Electrical Engineering

March
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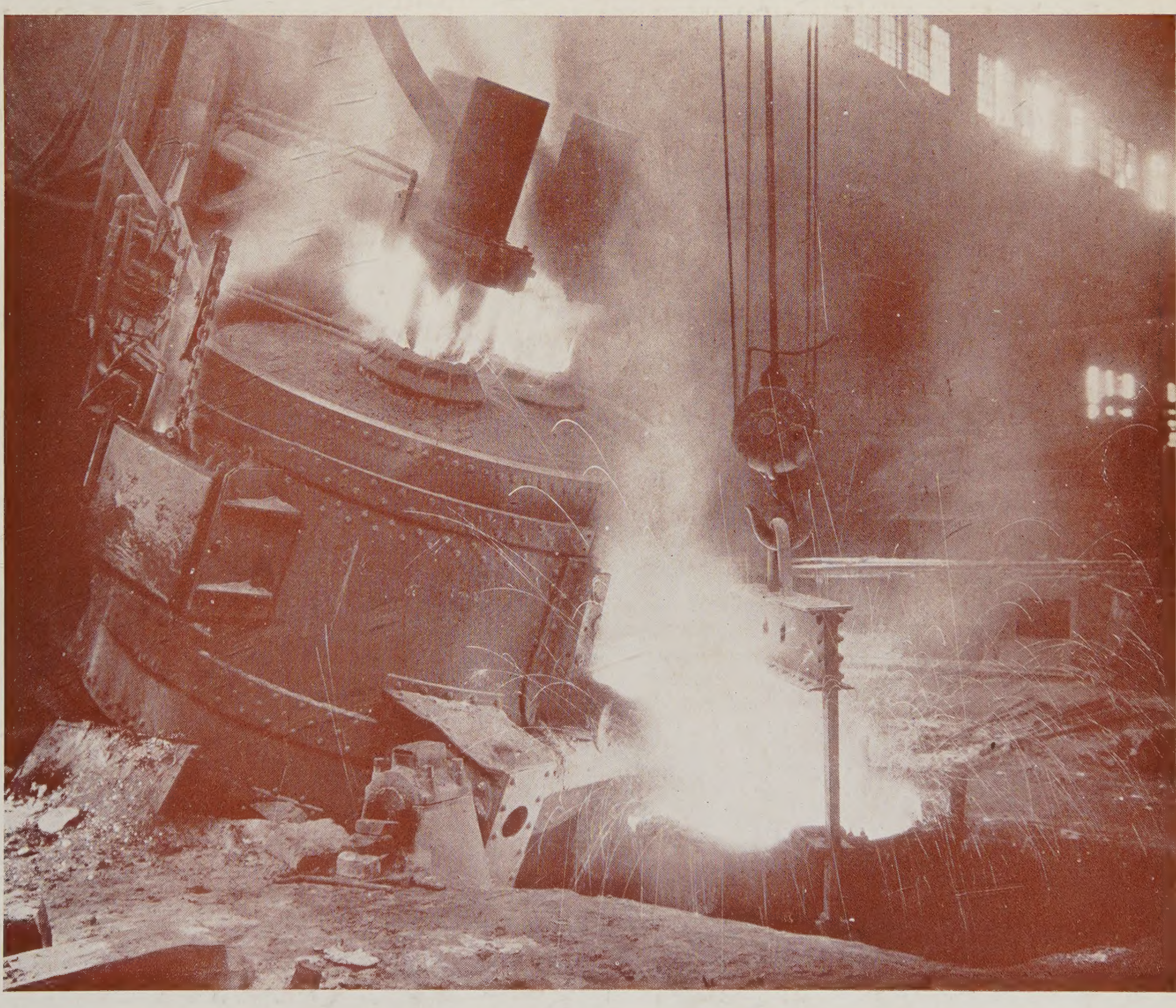

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FUTURE MEETINGS

of the

American Institute of Electrical Engineers

Place	*Dates*	*Nature*	*Latest Date for Receipt of Manuscripts*
Rochester, N. Y.	April 29-May 2, 1931	District Meeting	(Closed)
Asheville, N. C.	June 22-26, 1931	Summer Convention	March 23, 1931
Lake Tahoe, Cal.	Aug. 25-28, 1931	Pacific Coast Convention	May 25, 1931
Kansas City, Mo.	Oct. 22-24, 1931	District Meeting	July 22, 1931
New York, N. Y.	Jan. 25-29, 1932	Winter Convention	Oct. 26, 1931
Milwaukee, Wis.	March 14-16, 1932	District Meeting	Dec. 14, 1931

NOTE: Members who are contemplating submitting papers for presentation at any of the above meeting should communicate promptly with Institute headquarters, 33 West 39th Street, New York, N. Y., so tha their papers may be docketed for consideration by the Meetings and Papers Committee, as programs for al meetings are formulated several months in advance. Upon receipt of this notification, Institute headquarter will mail to each prospective author information in regard to the Institute's rules relating to the preparatior of manuscript and illustrations.

MEETINGS OF OTHER SOCIETIES

SOUTHEASTERN DIVISION, N. E. L. A., Vinoy Park Hotel, St. Petersburgh, Fla., (C. M. Kilian, 509 Haas-Howell Bldg., Atlanta, Ga.), April 1-3, 1931.

SOUTHWESTERN GEOGRAPHIC DIVISION, N. E. L. A., Mineral Wells, Tex., (S. J. Ballinger, San Antonio Public Service Co., San Antonio, Tex.), April 21-24, 1931.

AMERICAN ELECTROCHEMICAL SOCIETY, Hote Tutwiler, Birmingham, Ala., (C. G. Fink, Columbia University New York), April 23-25, 1931.

NORTHWEST ELECTRIC LIGHT AND POWER ASSO CIATION, Annual Convention, Boise, Idaho, June 17-20, 1931.

PACIFIC COAST ELECTRICAL ASSOCIATION, Annua Convention, Hotel Del Monte, Del Monte, Calif., June 24-26, 1931

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In This Issue—

—Turn to Next Page—

THE EDISON MEDAL for 1930 was presented January 28 to Dr. Frank Conrad by W. S. Lee, president of the Institute, following a eulogy effectively delivered by Dr. Chas. F. Scott, past-president and 1929 Edison medalist. (*See page 216*)

KARL TAYLOR COMPTON, president of the Massachusetts Institute of Technology, characterized the electron as mankind's most nimble and effective servant in his demonstration lecture at one of the Institute's winter convention sessions. Dr. Compton did not attempt to reveal anything new and startling concerning the electron, but he did outline rather comprehensively the present status of scientific understanding of that most minute and highly animated particle of matter. (*See page 192*)

PROTECTIVE RELAYS and related automatic devices are correctly accredited with having done much to make possible long distance power transmission and to facilitate the handling of the great electric power concentrations required to meet ever-growing demands. Everett E. George describes the reactance relay installation of the Tennessee Electric Power Company, one of the first and most extensive applications of this relatively new device. Operating experiences are outlined in order that others may profit thereby. (*See page 205*)

SOME OF THE MYSTERIES of electrical porcelain are reduced to a far less serious proportion by a brief discussion of chemistry, materials, and manufacturing methods given by H. M. Kraner. (*See page 209*)

FARLEY GRANGER CLARK (A '01; M '12; F '13) is the ardent proponent of a rather comprehensive plan for improving the operating economies of electric power systems through definite efforts to provide an outlet for "surplus" power. Mr. Clark suggests that surplus power available from existing generating stations at other than peak-load periods can well be absorbed in various industrial and particularly electrolytic processes involved in the manufacture of many commodities, including fuel gas. Mr. Clark graduated from Cornell University in mechanical engineering, class of '94; from 1897 until 1902 he was with the Metropolitan Street Railway Company (N. Y.); 1903-4 with Westinghouse, Church, Kerr & Company (N. Y.); 1905-10 with the Pennsylvania Railroad; 1911 with the Westinghouse Company; 1912-22 chief engineer of the Toronto (Canada) Power Company and affiliates. Since 1923 he has been in private consulting practise. (*See page 197*)

ANOTHER PHASE of the cooperative work of the communication and the electric service utilities in the interest of improved service to customers, revolves around the joint use of poles for the lines of the two utilities. J. C. Martin of the Middle West Utilities Company, and H. L. Huber of the American Telephone and Telegraph Company, each a transmission authority in his own field, have jointly produced a comprehensive outline of the present situation and current trends as regard cooperative work on joint pole use. (*See page 203*)

THE WINTER CONVENTION technical sessions with their wealth of material as represented by some fifty papers are comprehensively "covered" in ten news items. Some of the extensive discussion at four of the sessions is summarized; some further discussions will be presented in a subsequent issue. (*See pages 216-228*)

ONE of the most interesting factors influencing the trend of development of large electric generators, synchronous condensers, and similar rotating equipment, is the advent of hydrogen gas as a cooling medium. M. D. Ross, associated with the development of this type of equipment for the Westinghouse company, describes some of the problems and outlines some of the possibilities. (*See page 211*)

Pittsburgh, Pa., where the American Institute of Electrical Engineers will convene March 11-13, 1931, for a regular meeting of the Middle Eastern District (No. 2). For the news story of this meeting see the April issue of ELECTRICAL ENGINEERING

NOISE REDUCTION is being aggressively pushed from many different angles. R. B. GEORGE of the Westinghouse company describes experiments in controlling and reducing unpleasant noises emanating from power transformers and makes useful suggestions. (*See page 194*)

TRAFFIC CONTROL, a vexing problem affecting an ever-increasing percentage of the general public, bids fair to be simplified greatly through ingenious applications of that most versatile device, the electron tube. R. C. HITCHCOCK, Westinghouse research engineer, describes some successful practical experiments in the use of light beams to operate traffic signals. (*See page 182*)

WITH THE RECENT announcement of the Pennsylvania Railroad that it would proceed at once to complete the electrification of its main lines between New York City and Washington, D. C., and the announcement of electrification projects contemplated by other large railway systems, the question of railway electrification is assuming ever greater importance in engineering and economic circles. EDWARD L. MORELAND, well known consulting engineer and partner in the firm of Jackson & Moreland, Boston, who personally supervised the most important phases of the recently completed extensive electrification of the Lackawanna suburban lines serving New York City and New Jersey territory, discusses the important features of the project, several of which have established new precedents in the art. (*See page 185*)

WILLIAM STATES LEE (A '04; M '03; F '13) active, competent, and aggressive president of the Institute, answers in detail a lengthy telegram from the Honorable Gifford Pinchot, governor of the commonwealth of Pennsylvania. In his letter, President Lee corrects certain misunderstandings which were evidenced by the telegram which Governor Pinchot sent under date of January 28 addressed jointly to President Lee and the winter convention assemblage of the Institute. (*See page 215*)

FOR THE FIRST TIME in so comprehensive a manner, the present trends in telephone and power practises as they affect inductive coordination are set forth, so that all who are interested may know something of the more important factors underlying the important engineering cooperative efforts between the communication and the electric service communities. W. H. HARRISON, American Telephone and Telegraph Company authority on the subject, and A. E. SILVER of the Electric Bond & Share Company representing the electric service utilities, not only are well qualified to discuss the subject but represent also tremendous aggregations of engineering ability. (*See page 176*)

WILLIAM J. FOSTER of Schenectady, N. Y., has been awarded the Institute's Lamme medal which will be presented during the summer convention at Asheville, N. C., June 22-26, 1931. Dr. Foster receives the award "for his contributions to the design of rotating alternating-current machinery." (*See page 229*)

Telephone and Power Practises As They Affect Inductive Coordination

Proper coordination of parallel power and telephone circuits to control the noise induced in the latter is one of the oldest and most important problems requiring the joint consideration of power and telephone companies throughout the United States. Progress in the development of the telephone and power industries to meet growth and improve service, has an important influence on problems of coordination. Important trends and their influence are summarized in this paper.

By ***W. H. Harrison*** *and* ***A. E. Silver***

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New York

Fellow A. I. E. E.
Electric Bond & Share Co.,
New York

THE MANY important benefits resulting from the cooperative handling of questions arising from the proximity of the lines of the telephone and electric power systems of the United States are emphasized by the extent and the rapid growth of these two industries. Such a rate of growth (see accompanying illustrations) necessarily brings with it many cases of physical proximity where, because of the widely different characteristics of the circuits involved, difficulties might arise. The necessity for active study of the coordination of the different systems and for the current handling of large numbers of individual situations will continue for a long time to come.

In approaching the technical phases of the subject of coordination it seems well to emphasize the fact that, after all, the power and telephone companies serve essentially the same customers, and thus it is essential that both services be rendered in the most economical manner. Each utility, therefore, should construct its plant with full regard for the plans and facilities of the other.

The Joint General Committee of the National Electric Light Association and the Bell Telephone System has recommended principles and practises which recognize these fundamental factors and which point the way to the practical handling of each type of situation. In effect, each individual situation is contemplated to be worked out on the basis of the best over-all engineering solution, just as if both utilities were under one management. Without this basis of procedure it is hard to visualize how, with the service density of both utilities steadily mounting and with both the services rapidly extending into new territory, it would be possible to carry on these extensions in the present orderly fashion.

In the following are outlined some of the more important developments in the telephone and power industries, together with their effects upon coordination problems.

Perhaps the most important of these developments in both the power and telephone fields have to do with constant improvement in the quality of service afforded to customers. This trend is exemplified in the power system by fewer service interruptions, better voltage regulation, and better frequency regulation. In the telephone system this progress is marked primarily by the generally improved characteristics of transmitted speech and faster and more reliable service; secondarily, by a tremendous extension and widened scope of direct-connected voice communication channels.

In the telephone system the improvement in standards of service, if considered by itself, tends to increase the noticeability of inductive effects from outside sources. Similarly, increases in the extent of service and speed of completing calls have led to increased reliance on prompt telephone communication, tending to increase the importance of avoiding interruptions. Five years ago the average interval of time between the placing of a long distance toll call by a subscriber and the commencing of the conversation was 7½ minutes; at the present time it is a little less than 2½ minutes.

The improvement of service has been associated with a particularly rapid growth of very "long haul" telephone business and a consequent increase in the average length of telephone circuits used for interurban and long distance work. In the period 1925-29, while telephone toll business as a whole increased 59 per cent, New York-Chicago business increased 170 per cent and the combined Chicago and New York business to Los Angeles and San Francisco, 380 per cent. From the standpoint of coordination with other electric circuits the very long telephone circuit offers a more difficult problem than the circuit of moderate length because of the cumulative effect of exposures in different sections.

In the power industry one of the most important items in the improvement of service has been the steady decrease in the number of service interruptions. This has

From "Trends in Telephone and Power Practise as Affecting Coordination," **(No. 31-21)** presented at the A. I. E. E. winter convention, January 26-30, 1931, as Part 1 of a symposium on coordination of power and telephone plant.

been brought about mainly by better standards of construction including more systematic mechanical and electrical arrangement of circuits and apparatus, and increased numbers of circuits and sources of supply. While the increasing numbers of interconnecting and other types of lines bring new conditions requiring coordination of power and telephone plants, improved construction and increased security of circuits and apparatus have a definitely beneficial effect upon matters of coördination by reducing the number of abnormal conditions of operation. Better voltage regulation and certain accompanying factors which definitely aid coordination include better balance of currents in the separate phases of the circuits and more effective arrangements minimizing the tendency of currents to flow in the earth.

While in some respects the extent and rapid growth of the two utilities and the improvement of service standards have tended to increase the importance and the difficulties of coordination work, these adverse tendencies have been offset by beneficial effects of improvements in plant design and construction and by the cooperative endeavor which has been carried on by the two utilities during recent years. It is a tribute to the effectiveness of this cooperative work that the degree of satisfactory coordination between the two systems is steadily improving.

In the following pages brief statements are made descriptive of the more important trends in the respective systems.

Trends in Telephone Practise

Present trends in telephone system include:

1. Dial system.
2. Extension of toll cable.
3. Increased use of telephone repeaters.
4. Carrier telephone systems.
5. Improved station apparatus.
6. Connections to foreign countries.

Extensions in the telephone toll system and improvements in the service generally, tend to increase the number of coordination problems and their importance. Extended use of toll cable tends to reduce these same problems, since cable is less susceptive than open wire and its use allows many more circuits to be carried over a single route, thereby reducing the number of routes.

Probably the most fundamental and far reaching of these changes is the progress of conversion from manual to dial system operation. When present plans are completed approximately 80 per cent of the telephones of the Bell System will operate on a dial basis. While this trend is of the greatest and most fundamental importance in the development of the telephone business it does not affect the coordination problem in any material way and therefore need not be further discussed here.

One of the most spectacular trends of development of the Bell System at the present time is the increase in the connections to foreign countries. Earlier connections to Canada and Cuba were supplemented in 1927 by service to Mexico and by transoceanic radio links from New York to London through which connection is made to the principal European countries; and in 1930 a similar radio link from New York to Buenos Aires through which connection is made to Montevideo, Uruguay, and Santiago, Chile. During the next few years it is expected that these foreign connections will increase to include all important points in South America, Australia, Japan, Honolulu, and all other points which may offer an appreciable demand for service. These intercontinental circuits are not directly affected by the physical proximity of power circuits; but their efficiency is affected by noise currents on connected circuits.

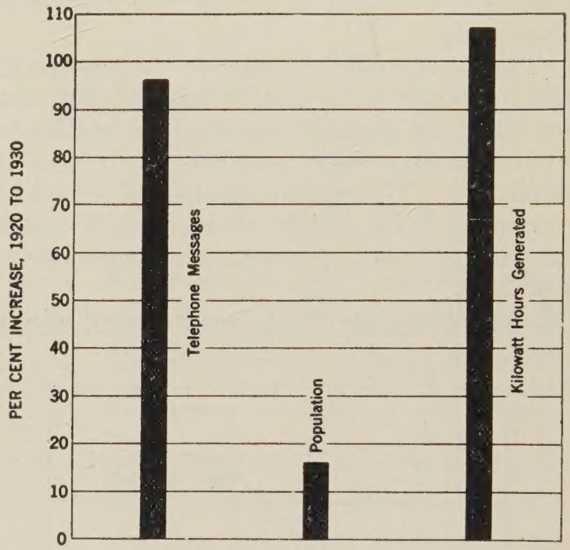

Fig. 1. Growth in the utilization of power and telephone service as compared to growth in population for the period 1920-1930, expressed in percentage of increase

Toll Cable Increasing

The change in methods of designing and constructing toll circuits which is of greatest importance is the great increase in use of cables for such circuits, including both the very long distance circuits and the shorter interurban circuits. A single cable may provide from 250 to 500 telephone circuits and several hundred telegraph circuits, as many circuits as would be supplied by from five to ten heavily loaded open-wire pole lines.

This concentration of circuits in a single cable, a number of which can be placed on a single route, of itself greatly simplifies coordination problems by materially reducing the number of routes involved.

Furthermore, the presence of the lead sheath with the twisting of the cable conductors, the high degree of balance with respect to ground, and the mutual shielding effect of the many circuits in one cable, practically prevent the direct induction of noise currents into the cable circuits from outside electrical sources. The shielding effect of the lead sheath when suitably grounded also provides substantial reductions in the voltages of fundamental frequency which may be induced along the cable conductors at time of trouble on neighboring power systems.

A telephone toll cable with its associated equipment costs about the same per mile as a twin-circuit power transmission line of the 110-kv. class. This high cost has led to a large use of private rights-of-way for new extensions of these cables, particularly for aerial cable construction—an added advantage from the coordination standpoint.

In all types of cable construction the susceptiveness to noise induction is so greatly reduced that low frequency induction generally becomes the limiting factor relative to the permissible proximity of these cables to power circuits. The relative amounts of induced voltages occurring with certain types of cable construction as compared with open-wire construction are in the order of 1:5.

While as noted cable circuits are protected effectively from noise induction, the efficiency obtainable over the long circuits is limited in part by the noise currents occurring in the open-wire lines which may be switched to the long cable circuits. This is because the efficiency of the long cable circuits depends upon voice-operated switching devices which must not be operated by the noise currents. This is true also of the intercontinental circuits. Extension of the circuits controlled by voice-operated devices therefore tends to increase the importance of good coordination of the entire plant.

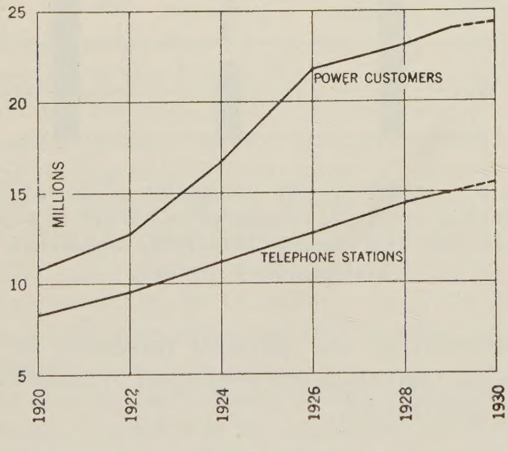

Fig. 2. Growth in the number of telephone subscriber stations and electric power customers for the decade 1920-1930

Repeaters and Carrier Systems

Another important trend of practise is the wide use of telephone repeaters, the purpose of which is to amplify the voice currents and thus make possible higher efficiency and greater extension of long distance telephone circuits. Without repeaters it was necessary on the long open-wire circuits to permit the power level of voice currents to sink to relatively low values. An extreme example of this is given by the New York-Denver circuit which, before repeaters were available for use, had an over-all ratio of output power to input power of 8:10,000. With the application of repeaters, the level of voice currents can be kept relatively high throughout the circuit.

The use of repeaters thus contributes to reducing the susceptiveness of the telephone plant and aids coordination. On a circuit such as the original New York-Denver circuit a relatively small amount of noise current greatly impaired transmission because of the weak incoming voice currents.

A third important trend in telephone practise is the extension in the use of carrier telephone systems for long circuits and the associated changes in aerial wire construction practises. The carrier systems are much less influenced by noise induction from power circuits because they occupy a range of frequencies (5,000 to 30,000 cycles) in which the harmonic power voltages or currents ordinarily are extremely small.

Subscribers' Station Apparatus

To a great extent the trend of development in subscribers' station apparatus is toward new arrangements which provide fuller convenience and more closely meet the needs of the users, and which have no material effect upon the coordination problem. An important group of developments, however, centers about the improvements in electrical performance of station apparatus accomplished by removing impairments caused by the earlier types of apparatus. These changes, by improving the quality of speech as reproduced by the telephone system, tend to make more noticeable the impairments caused by the effects of currents induced from external sources.

The tendency toward an increase in the range of voice frequencies efficiently reproduced by the telephone system tends to increase also the range of induced currents which may cause noise interference. An extreme illustration of this is represented by the circuits designed to transmit programs for radio broadcasting stations. Transmission characteristics of these circuits have been improved to accommodate efficient transmission of currents of frequencies ranging from 35 to 8,000 cycles per second. Thus these circuits are susceptible to inductive noises over this same wide range.

Room noise at subscribers' premises, besides acting directly on the ears of the telephone user, is converted

by the transmitter into electrical currents which in turn produce receiver noise. Efforts now being made to reduce these effects inevitably will tend to bring into increasing prominence noises caused by induction which now in many cases are partially overshadowed by reproduction of room noises.

To offset this tendency, at least partly, steps have been taken to improve the degree of balance-to-ground of new station apparatus, particularly in the case of party lines.

Other Items

Other features not directly associated with these trends, and introduced into the telephone plant largely because of the advantages to be gained in reducing susceptiveness to electrical influences, have afforded other benefits also. Interesting examples of these changes include recent adoption of soldered joints to replace twisted sleeve joints and the substitution of copper for iron wire on short tributary toll circuits. In toll offices improvements have been made in the balance of coils and condensers used for superposing telegraph on the telephone circuits. The use of repeating coils, commonly used for side-circuits, has been extended to phantom toll circuits. These coils act as insulating transformers to prevent noise voltages from the outside conductors being impressed upon the intricate cabling and equipment of the office.

Referring to the local plant, there are several noteworthy examples of modifications made principally for the purpose of reducing susceptiveness. Coordination investigations such as were conducted at Minneapolis by the joint general committee have stimulated the development of means for reducing the susceptiveness of the telephone distribution plant.

With the rapid increase of voltage and capacity of power circuits generally, experimental studies have been undertaken to ascertain further means of maintaining the safety of persons working or listening on telephone circuits. At the present time, development work is under way on various devices for this purpose, some of which are fundamentally different in design and operation from those previously used. It is hoped that these devices will afford increased protection against overvoltages and improve coordination and conditions.

Trends in Power Practise

Current trends in power system development include:

1. Interconnection of large systems.
2. Higher transmission and distribution voltages.
3. Larger generating units.
4. Improved system stability.
5. Control of the effects of lightning.
6. Underground construction.
7. Improved wave shape.
8. Increasing use of automatic devices.
9. Better frequency regulation.
10. Better voltage regulation.

The first three items are likely to increase the number of coordination problems and make certain of them more difficult; distinct help in reducing the coordination problem is afforded by Items 4-7 inclusive; the last three may be said to be beneficial but of less importance.

Those trends in power system development which are

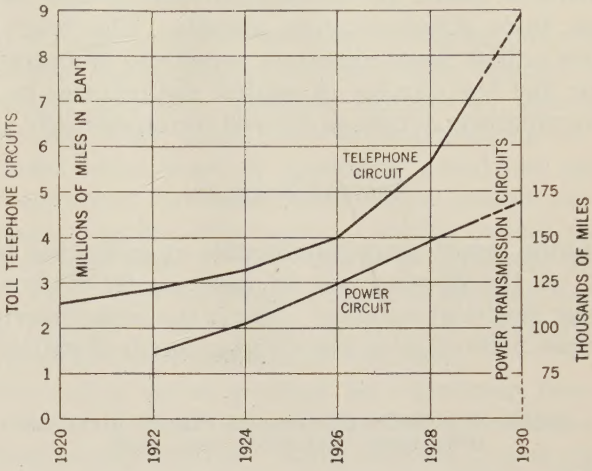

Fig. 3. Record of a ten years' growth in mileage of long distance telephone toll circuits and electric power transmission circuits of 11 kv. and higher. Telephone circuit mileage is given in millions; power circuit mileage in thousands

more directly concerned with matters of coordination are discussed in the following paragraphs.

System Voltages

Statistics show that the rate of increase of transmission line mileage, as a whole, is lagging behind the rate of growth of both installed generator capacity and electricity production. Furthermore, mileages of the higher transmission voltages (220 kv., 132 kv., 110 kv., and particularly 66 kv.) are growing at a more rapid rate than the group average. These comparisons reflect the increasing utilization of the higher voltages with the greater circuit capacities they provide.

In the distribution field also, coincident with the development of rural service, there is a movement toward higher voltages in primary circuits. Voltages from 6.6 kv. to 13.2 kv. and higher have been used in rural work. In urban areas the high load densities encountered have brought about replacement of the lower by higher primary voltages. In addition to the greater capacities provided by the higher voltages, possibilities of system simplification by combining rural and urban systems to eliminate voltage transformations are of considerable economic importance.

While at first glance the pronounced trend to higher transmission and primary distribution voltages may

appear to enhance the difficulties of coordinating communication and power lines, certain offsetting factors enter. As transmission voltages increase there is a definite trend toward direct cross-country private rights-of-way which automatically provide greater separation from communication circuits.

In the case of distribution lines, too, the adoption of increasingly higher voltages is accompanied by more systematic grades of construction and greater clearances from communication circuits. The result of course is that fewer abnormal conditions of operation occur and the number of related disturbances in the communication circuits is reduced correspondingly.

System Stability

During recent years considerable attention has been paid to the development of methods for improving system electrical stability. One of the most important of these methods is the use of higher speeds of switching—at present, faults can be cleared in 15 cycles, or less, of a 60-cycle wave. So far, high-speed switching has been applied mainly to transmission circuits. However, as development proceeds and cost of equipment required is reduced, the field of application of high-speed switching may be extended to distribution systems. The result in the case of either transmission or distribution will be of course to reduce the duration of transients.

MILES OF INDUCTIVE EXPOSURE PER 100 MILES OF OPEN-WIRE TELEPHONE TOLL LINE

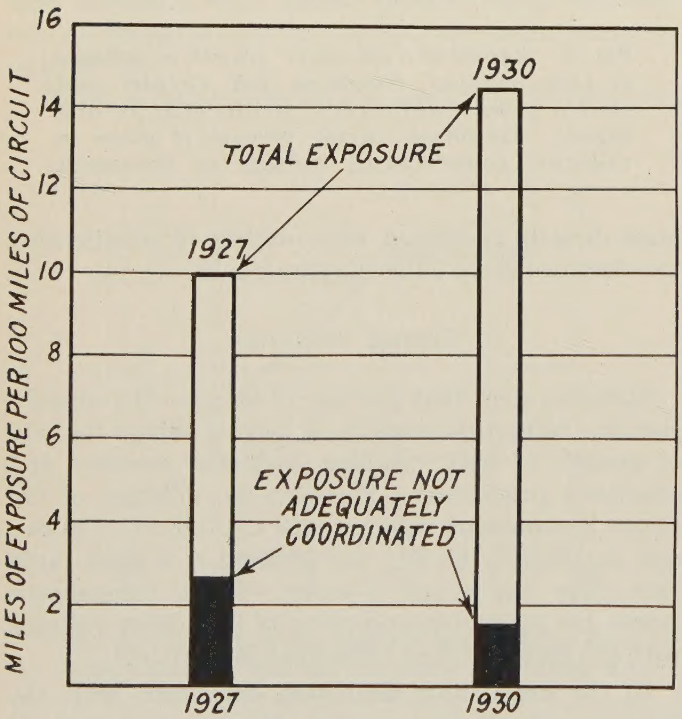

Fig. 4. Concrete evidence of the beneficial effect of the methods developed through the joint efforts of the power and telephone industries

Akin to high-speed switching, the use of high-speed excitation of rotating equipment has been developed. This may tend to increase the maximum fault-current values somewhat, which would make coordination more difficult. However, the reduction in severity of instability surges, in so far as such surges involve faults to ground, affords definite benefits from the coordination standpoint. Further study and observations are required to determine what, if any, inherent limitations or advantages high-speed switching may possess with respect to coordination work.

With the growth in power systems and major interconnections, the use of bus or feeder current-limiting reactors or other means of limiting the concentration of fault-current flow is being given increasing application. Such practise acts to restrict the magnitude of inductive transients. In distribution systems the growing use of feeder reactors has a similar effect upon coordination.

It is predominant practise in America to ground the neutrals of transmission systems at important transforming centers, sometimes through resistors or reactors, but usually solidly; thus, a large proportion of the transformers of higher voltages now in service have insulation between the neutral ends of the grounded windings and the core designed to withstand only the neutral potentials produced by fault currents regulating through the unavoidable impedance of grounding connections. Economies resulting from this method of construction become greater as rated operating voltages rise. However, the use of solidly grounded neutrals tends to make coordination more difficult in view of the possibilities for increased flow of earth currents. Increasing study and consideration are being given to the use of current-limiting devices in the neutral where the characteristics of the apparatus and limitations of relaying will permit such operation. The increasing use of neutral impedances and other types of current-limiting devices aids coordination through reduction in the magnitude of abnormal induction.

Lightning Control

The major problem of the transmission art at the present time is the control of lightning in its effects on service. In those sections of the country in which lightning is prevalent, this natural hazard accounts for a large proportion of transmission circuit faults, approaching 100 per cent for the higher classes of trunk transmission lines. Present measures directed toward the control of service interruptions caused by lightning include improved application of overhead ground wires, improved grounding connections at the supporting structures, greater use of wood for lightning insulation, the use in shunt with line insulators of fused gaps, or

other valve devices to "spill" the surge without dynamic current follow-up. There is under consideration also the application on grounded-neutral systems of single-phase switching. All of these measures, with the exception of the last, are helpful from the coordination point of view since their effect is to avoid or reduce system faults or at least to decrease the magnitude of earth fault currents and hence, of the accompanying voltages induced in nearby communication circuits.

Underground Construction

Underground construction in distribution systems seldom is economical; but it is increasing in high-load-density districts and in some residential areas primarily in response to requirements for civic improvements and the relieving of surface congestion. Coincident with the more recent developments in underground distribution, certain special situations have brought about the development of underground cable suitable for use in high-voltage transmission circuits, including 132-kv. Underground installations involving these transmission voltages are comparatively few in number and small in extent. Underground construction of both distribution and transmission circuits has a definitely favorable effect upon coordination problems.

Aerial cable construction for both distribution and transmission circuits has been used to a limited extent and has a definitely beneficial effect upon coordination matters. Whether this type of construction will be extended in the future is not evident.

Grounding of Distribution System Neutrals

Because of the difficulties encountered in distribution systems in obtaining adequate grounding of primary and secondary circuits, the establishment of neutral networks grounded at many points has become a practise. In most past cases separate primary and secondary networks have been provided, but recently in several localities, the two have been combined into a common-neutral arrangement providing increased multiplicity of ground connections. Wider use of the system is probable.

This common-neutral arrangement introduces features of interest from the coordination standpoint, because of the increased opportunities for the flow of currents through the ground. Experience and investigations so far, however, indicate that with adequate attention to coordination, this arrangement is comparable in its effect on neighboring communication circuits to other types of distribution systems.

Wave Shape

Connection of primary circuits directly to generating station buses results in service and economic advantages through elimination of transformations, thereby improving voltage regulation and aiding system simplification. This practise, however, tends to make coordination more difficult because harmonics which may be present in the generated voltage can flow directly out over such circuits. However, the important bearing of generator and apparatus wave shape upon the coordination problem long has been realized and is receiving increasing attention.

It is recognized that there is a median beyond which, (to avoid the alternative of applying in specific cases available and less expensive methods of externally correcting wave shape,) general improvement in the inherent wave shape of apparatus would not justify the attendant increased difficulties of design and increased manufacturing costs. Looking toward establishing a measure of wave shape in apparatus design which will strike an economic balance between benefits and burdens, work is now in progress cooperatively between the manufacturers and the users.

Increasing use of rectifiers for conversion from alternating to direct current also has an influence on inductive coordination. Study devoted to this matter has revealed methods for control of the distortion of the d-c. voltage wave caused by the rectifiers, and a solution of this part of the problem appears to be in hand. Progress in the design and application of apparatus, and the better understanding of the influence of circuit and transformer connections on inductive relations, indicate that problems concerned with wave shape may be expected to decrease steadily.

Conclusions

In reviewing this subject one is impressed by the number of ways in which the coordination problem touches both the telephone and power fields, and with the very large amount of cooperative work which already has been done. This work, as has been indicated, has resulted in noteworthy progress in the satisfactory handling of coordination matters of all characters. The situation concerns two industries which are in a period of rapid development and change, both as regards their size and as regards the physical arrangements which constitute their plants. Many new developments in each plant require consideration from the standpoint of coordination.

It is evident, therefore, that if the ground already gained is to be held, and further progress made, the channels of cooperation between the two industries must be kept in operation for the consideration of new problems arising with new developments in the industries, as well as for the further perfection of the cooperative methods of handling existing specific problems.

Light Beams Operate Traffic Signals

Efforts to perfect automatic devices which will give major highways a green light at all times except as change is actually required by traffic on minor intersecting streets now have turned to the grid-glow and photoelectric tubes. Operating experiences gained from trial installations are discussed and equipment features are outlined.

By R. C. Hitchcock

Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

TRAFFIC CONTROL at intersections of streets carrying light traffic with streets or boulevards carrying through-city or cross-country traffic presents one of the most perplexing problems with which police departments and other traffic controlling bodies have to deal. The problem is complicated still further when it is considered that the ratio of major traffic to minor traffic may vary as much as from 3:1 to as high as 50:1, or even higher on some occasions, at the same intersection.

Devices employing photoelectric and grid-glow tubes actuated by light beams provide automatic adjustment of signal operation to traffic requirements by maintaining a green or "go" signal on the major traffic street at all times when there is no traffic on a minor intersecting street.

Devices actuated by traffic on both of the intersecting streets are in use in some locations, with no special signal program. Such equipment must be very carefully designed and frequently inspected, for should failure occur in any unit, signals may remain as they were at the time of failure. With the major-minor device described here, the failure of any of several units causes the vehicle-controlled light-beam device to be disconnected automatically, and the regular timer motor which is incorporated into the apparatus, to then control the traffic at the intersection on a predetermined cycle.

As an example showing how this system may be applied to a typical major-minor intersection, assume a one-minute traffic cycle with a timing of: 42 sec. major street green, 3 sec. amber, 12 sec. minor street green, and 3 sec. amber. Thus the ratio of green light for major and minor streets is 42:12 or 3.5:1; yet this timing is frequently used at an intersection where the traffic ratio ranges from 10:1 to 50:1, and where 1,000 or more cars per hour are passing on the major street. The reason for the short major cycle is to allow the minor street vehicles to enter the intersection after a maximum waiting time of 45 sec. All this is done with the new automatic controller; at the same time the major street is allowed as much more than a 42-sec. green-signal period as the minor traffic permits. In addition, after the first 45 sec. of major street green, the minor traffic wait is only about 5 sec., or just long enough for the automatic device to function.

From "Traffic Control by Light Beams," (**No. 31-34**), presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

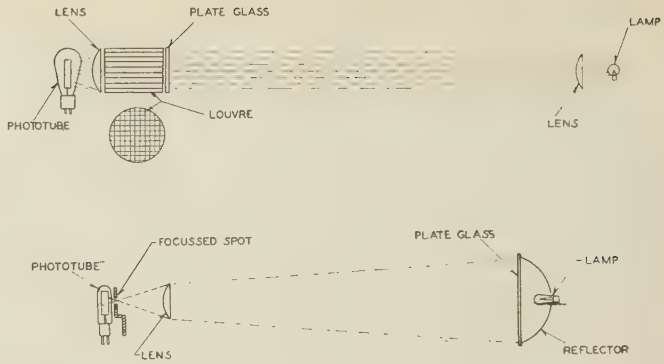

Fig. 1. Optical systems showing light-beam transmitting and receiving apparatus: (above) second installation; (below) third, improved installation

Early Experimental Installations

During the early development work on this apparatus, in order to study the performance of the devices under actual operating conditions two trial installations were made at minor intersections.

Fig. 2. Location of control units at intersection of minor street with William Penn—Lincoln Highway, Wilkinsburg, Pa.

In the first installation vertical light beams were used; but so much difficulty was experienced with grease and dirt falling on parts of the apparatus mounted below the street surface that this installation soon was discontinued. In subsequent installations a horizontal light beam has been used, placed at such a height that it can be operated by any type of vehicle now on the market. The optical system used in the second installation is shown in Fig. 1; as may be noted, a lens system focussed an image of the lamp filament on the photoelectric cell through a louver. This louver consisted of a square, sectional honeycomb which passed light parallel to its axis but prevented the passage of light entering at an angle of even a few degrees.

One interesting problem encountered during early experiments was the operation of the signals by cars making turns from the major into the minor streets. Thus a green light would be given to the minor street with no traffic waiting for it. This problem was solved by introducing a time-delay relay into the light beam operating circuit. This relay was timed so as to require an approaching vehicle to intercept the light beam for several seconds before a change of signal lights took place. In this way no change of signal lights such as those caused by vehicles making turns resulted from momentary interruptions to the light beam.

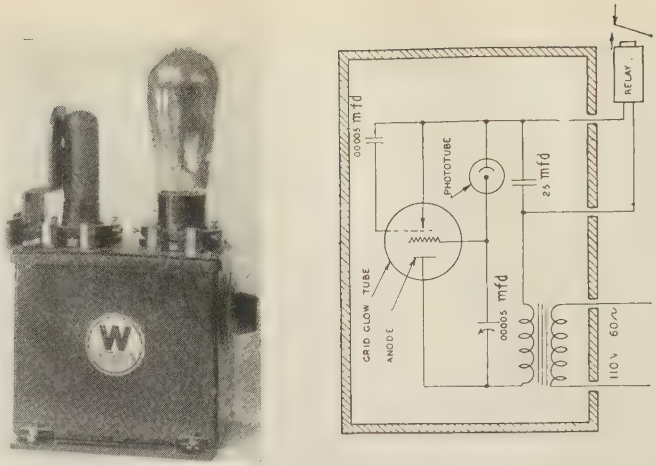

Fig. 4. Grid-glow phototube unit showing schematic wiring diagram and complete assembly of device

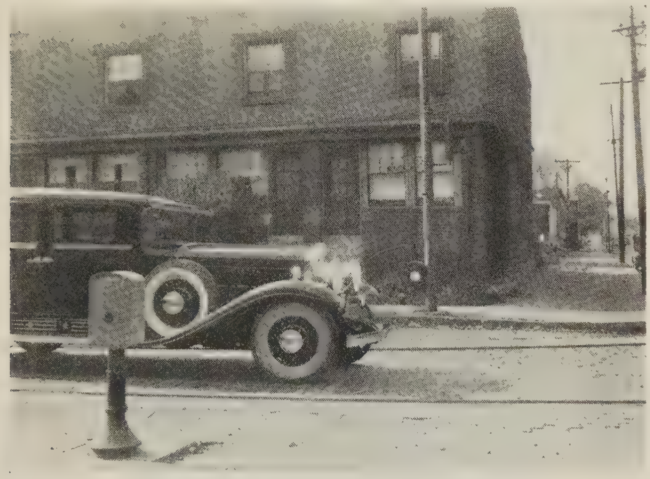

Fig. 3. Vehicle intercepting horizontal light beam

Unusual reliability for a device still in the development stage was demonstrated by this second installation. After five months' operation only three interruptions have occurred—two of these due to dirty lenses and resulting from the apparatus going on "program" operation; and the third due to a loose connection which resulted in one relay box being out of service for about two hours. Also during this period, one of the lamps in this installation for $4\frac{1}{3}$ months burned out and after $4\frac{1}{2}$ months one of the original glow tubes was replaced.

Third Installation

With certain changes as dictated by operating experiences with the second installation, a third set of apparatus was built and installed in Wilkinsburg, Pa., at the intersection of a minor street with the street which carries traffic from both the William Penn and Lincoln highways through the town. This installation was completed on September 16, 1930. Location of the control boxes at this intersection is shown in

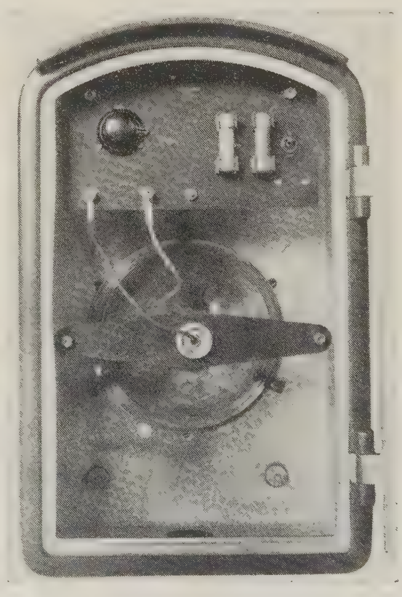

Fig. 5. Rear of reflector unit showing lamp mounting, rheostat, and switch

Fig. 2. A vehicle intercepting the light beam in one set of these units is shown in Fig. 3.

Fig. 4 shows the grid-glow phototube unit used in the third installation. Paraffin-impregnated cork washers together with a special clamping device were found to keep the tube bases free from moisture and dirt. Both the transformer and condensers with their associated wiring are contained inside of a small casting, as shown. The upper panel is made of moldarta and is screwed to the casting with a paraffin-cork gasket to keep it moisture-tight. The no-load loss of the transformer provides sufficient heat to prevent condensation of moisture within this casting. In this connection, tests were made with the grid-glow phototube unit in a humidifier. With the humidity at 100 per cent, water was sprayed over the unit several times. Under these extreme conditions the paraffin-cork washers and gaskets held their seal and the unit operated satisfac-factorily for several hours.

The complete optical system of the third installation is shown in Fig. 1. With the exception of the front the glass of the phototube is painted black. This keeps daylight out of the tube so that with the back of the control box open adjustments may readily be made. As may be noted in both Figs. 1 and 4, a shield containing a small hole on which the light source is focussed, is placed in front of the phototube, thereby keeping out extraneous light.

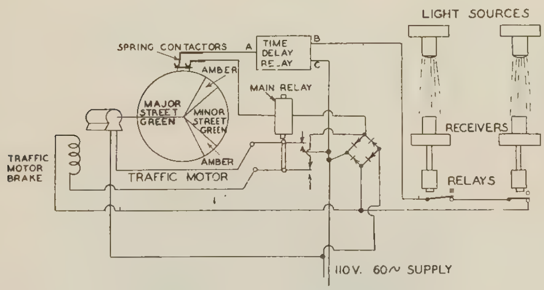

Fig. 6. Schematic diagram of latest installation

Experimental results indicate that a fairly good parabolic reflector such as used in this third installation is better than any reasonable-priced lens of similar diameter as used in the second installation. As a result of this improved optical system, lower lamp filament currents may be employed; this in turn means longer life for lamps. A rear view showing the reflector of the lamp-unit box may be seen in Fig. 5. The lamp socket has two knurled clamp nuts which allow motion of the socket in and out, while a large hole in the support permits lateral motion. A resistor is provided in series with the primary of the lamp transformer so that its voltage may be varied to suit.

Schematic wiring diagram for the third controller is given in Fig. 6. As shown in this diagram the major street signal is green, the main relay is pulled up, power is off the motor, and the brake is on. When a car crosses the light beam momentarily as in turning from the major into the minor street, the light-controlled relays pull up, and the circuit wires A and B of the time-delay relay are open-circuited. However, unless the car remains in the beam for the specified time delay there is no further action in the controller. But if a car does wait in the beam for the specified time, circuit A-B remains open, the traffic motor starts up, and the cycle begins, giving amber and then green to the minor street.

Arrangement of parts in the main control unit is shown in Fig. 7. This view shows the rear of the box at the top of which may be seen some of the time-delay apparatus. Of particular interest is the method of mounting the grid-glow-phototube unit which can be seen at the bottom of the box.

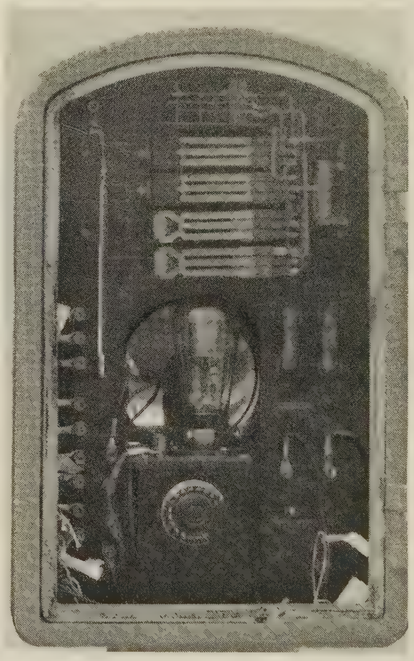

Fig. 7. Rear of main-control box containing grid-glow phototube unit and time-delay apparatus

It is interesting to note that at the time of writing this third installation has been in operation for about one month and no service interruptions have occurred. By actual timing, the major street has been found to receive a green signal for periods as long as five minutes at times of extremely light traffic on the minor street.

Operations described in the foregoing paragraphs have been accomplished purely experimentally; the equipment is not available for commercial usages.

Conclusions

In summing up the results so far obtained with these devices it may be said that:

1. The red light was flashed on the major street from 50 to 70 per cent less than when using the regular cycle timer.
2. Glass parts of the apparatus should be cleaned about once a month, at which time a routine inspection should be made.
3. Reliability of operation is assured by the traffic-timing mechanism incorporated into the apparatus.
4. Increased reliability with less frequent inspection will result with the use of the longer-life tubes now being made.

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Lackawanna Electrification Improves Suburban Service

Establishing a noteworthy precedent in the railroad world the Delaware Lackawanna and Western Railroad's recently completed suburban electrification places entire dependence upon 3,000-volt mercury arc rectifiers. Other features of design include the use of trolley voltage directly across car heaters, and general planning of all designs and equipment selections to permit extension of electrification throughout the system to serve overland freight and passenger trains.

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ELECTRIFICATION is enabling many steam railroads to solve problems of handling increasing amounts of suburban passenger traffic, where the bulk of such traffic comes in comparatively short morning and evening periods. The Delaware, Lackawanna and Western Railroad faced just such a problem in connection with its suburban lines in New Jersey when increasing demands made on these lines by New York traffic necessitated faster, cleaner, and more frequent train service. This was possible only through electrification.

In pursuing the present electrification program all designs and equipment selections were influenced by the ultimate possibility of complete electrification of the entire Lackawanna system, which includes both overland passenger and heavy freight service. A novel feature of the development is the use of 3,000-volt mercury arc rectifiers throughout for train supply. These devices have been proved to be lower in first cost and higher in operating efficiency at all loads than any other type of converting apparatus.

The present electrification covers approximately 68 route miles and 158 track miles of line in the suburban district west of Hoboken, N. J., and includes the main passenger line from Hoboken to Dover (via Newark, the Oranges, Summit and Morristown) and the branch lines to Montclair and Gladstone. It covers only local passenger service except for the electric transfer of freight trains between the freight classification yard at Secaucus and the terminal pier-head yard in Jersey City, adjoining the Hoboken terminal. In the passenger service multiple-unit cars are used exclusively, while for freight transfer service "three-power" locomotives are employed.

Power Supply and Substations

Power for the electrification is purchased from the three power companies serving the territories in which the substations are located, and is delivered by the power companies to the five railroad substations in the form of three-phase, 60-cycle alternating current, at the voltages available on the power companies' systems in the vicinity. There is no transmission of a-c. power by the railroad along the rights-of-way used for traction purposes.

The locations of the substations are shown on the map (Fig. 1). Power is supplied at the West End and Roseville substations by the Public Service Electric and Gas Company at 13.2 kv. and 26.4 kv., respectively; at the Summit substation by the Jersey Central Power and Light Company at 66 kv.; and at the Bernardsville and Denville substations by the New Jersey Power

From "Lackawanna Suburban Electrification," (**No. 31-18**) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

and Light Company at 33 kv. The West End and Roseville substations are supplied by underground cable circuits and each of the other three substations by overhead lines.

Four of the substations—namely, West End, Roseville, Summit and Denville—are at junction points and an operator will be kept in attendance at all times. They, therefore, are not equipped with complete automatic control, although many of the functions are automatic. The Bernardsville substation is fully automatic with supervisory control from the Summit substation 13.4 mi. away.

Mercury arc rectifiers are used exclusively for converting from 60-cycle alternating current to the 3,000-volt direct current required for traction purposes.

A-C. Supply Circuits and Control. A typical substation showing the arrangement and connection of the

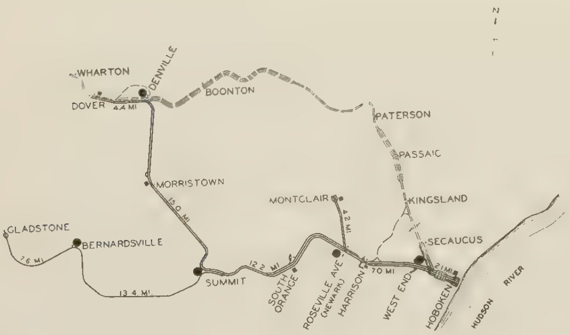

Fig. 1. Map of Lackawanna suburban lines east of Dover, N. J., showing electrified sections and substation locations

rectifiers and associated apparatus is given in cross-section in Fig. 2. A-c. switching structures are of the outdoor type in all substations.

Connections from the a-c. bus to the rectifier transformers are through oil circuit breakers with instantaneous overload protection. The main transformers have three-phase delta-connected primaries, with ratio adjusters externally operated from the ground, and all twelve-phase zig-zig secondaries are provided with protection against overheating.

At the West End and Roseville substations the incoming a-c. power feeders are connected to the bus through oil circuit breakers and disconnecting switches. Both of these substations are equipped with four twelve-phase transformers each supplying power to a twelve-phase, 3,000-kw. rectifier tank.

At the Summit and Denville substations the incoming a-c. power feeders are connected to the bus through horn-gap air-break switches. In these cases the oil circuit breakers in the power companies' substations supplying the feeder circuits are relied upon to clear the associated circuit in the event of a fault on a section of the bus. If, however, conditions on the power companies' systems should change so that the present method of operation would no longer be satisfactory, provisions are made for later installation of oil circuit breakers instead of the horn-gap air-break switches. These two substations are each equipped with two twelve-phase transformers each supplying power to two six-phase, 1,500-kw. rectifier tanks. Normally, both rectifier tanks of each two-tank unit will be operated together; but in event of failure of one tank of a pair, the faulty tank can be disconnected by opening disconnecting switches provided in the leads to the anodes, and the other tank operated alone.

At the Bernardsville substation incoming a-c. power feeders are also connected to the bus through horn-gap air-break switches. Normally this station will be supplied from one circuit, the second circuit being used only in case of failure of power on the first circuit. At this substation there are two twelve-phase, 1,500-kv-a. transformers, each supplying power to a twelve-phase rectifier tank.

In all stations, lightning protection to the a-c, bus is provided by oxide film-type lightning arresters.

D-C. Bus Arrangement and Circuit Control. On the d-c. side of each substation, main and auxiliary buses are provided, each bus being sectionalized by a disconnecting switch, but operated normally with the secionalizing switch closed. The d-c. feeders connecting the substation bus to the catenary system are controlled by high-speed circuit breakers of the magnetic blow-out type, with holding coils energized from a storage battery.

In all stations, a lightning arrester of the electrolytic aluminum cell type, with balancing resistor and shunted spark-gap, is provided on each d-c. feeder and on the d-c. main bus.

Bernardsville Automatic Substation. As previously mentioned, four of the five substations are manually operated. The fifth, Bernardsville, is fully automatic with supervisory control from the Summit substation. Normally power will be supplied to this substation over a single circuit, but provision is made for automatically throwing over to a second circuit in the event of failure of power on the first. Once having changed over to the second circuit, the system does not automatically change back to the first circuit on restoration of power on that circuit unless there is a failure of power on the second circuit.

The automatic features provide also that either of the two rectifier units may be made the preferred unit, and that the second unit will come automatically into service when the load on the first exceeds a predetermined amount; this second will then drop out automatically after a predetermined time delay when the total substation load drops below a certain amount. The preferred rectifier may be kept on the line continuously or the control may be further adjusted to bring it on only when there is a load demand on the substation, and to take it off the line after a definite time delay when the load has decreased below a predeter-

mined amount. In the event of a fault on either rectifier or any of its auxiliary circuits, that rectifier is automatically locked off the line. If the fault is on the preferred rectifier, the second rectifier will take its place automatically.

Signal and Auxiliary Power Supply. In addition to the 3,000-volt direct current supplied from the substations for traction purposes, each of the substations furnishes 2,300-volt, single-phase, 60-cycle power for signal operation. The West End, Roseville and Denville substations also supply 6,600-volt, three-phase, 60-cycle power for railroad auxiliaries, station lighting, and miscellaneous power requirements along the right of way.

Rectifiers. Rectifiers rather than motor-generators were selected for the conversion of the 60-cycle a-c. power to 3,000-volt d-c. power because of their relatively low first cost, high efficiency, ability to carry heavy overloads without injury, and the economy of substation design resulting from the small space occupied and the absence of heavy foundations required for motor-generators. Fig. 3 shows the comparative efficiencies of 3000-volt mercury arc rectifier sets and motor-generator sets of similar capacities.

These rectifiers were bought under a specification requiring guarantee of successful operation in service under loads of 150 per cent of current rating (50 per cent overload) for two hours and 300 per cent of current rating (200 per cent overload) for five minutes.

The rectifier tanks are equipped with the usual arc-striking anodes, holding (or exciting) anodes, vacuum pumps, and gages. The tanks are water-cooled, using a closed cooling system with forced circulation under thermostat control. The circulating water for each rectifier tank is re-cooled in a cooler unit associated with that tank somewhat similar to an enlarged automobile radiator using a circulating pump and motor-driven fan. Heating elements under thermostat control are also provided to prevent various parts of the rectifiers becoming too cool when shut down or lightly loaded.

D-c. smoothing reactors to reduce the ripple in the d-c. voltage, and resonant shunts to drain off high-frequency harmonics which would cause interference on communication circuits, are also provided. Surge suppressors made up of capacitors with limiting resistors are provided to protect the transformer secondary windings and the interphase transformer windings against high-voltage surges.

The shell of the rectifier tank and some of the associated equipment is at substantially cathode potential (3,000 volts above ground) when the rectifier is in operation. This equipment is therefore insulated from ground and carefully protected from accidental contact while in operation.

Fig. 4 is an interior view of a substation, showing the arrangement of the rectifiers and enclosing grilles.

In addition to the overload protection provided by the oil circuit breaker on the a-c. side of the transformer, each rectifier unit is protected by a high-speed circuit breaker of the magnetic blow-out type on the positive side (cathode connection) and by a similar high-speed circuit breaker short-circuiting a load-limiting resistor on the negative side (connection to mid-point of the interphase transformer).

Rectifier Grid Excitation. Aside from the voltage and capacity of the units, the outstanding features of the Lackawanna rectifiers are the anode grid excitation and the automatic compounding. In addition to the usual provisions for shielding the anode from the mercury thrown up from the cathode mercury pool by the arc stream, each anode is also surrounded by an inner shield suspended from a porcelain insulator. This shield supports a mesh grid made of special high-melting-point metal and mounted just below the face of the anode; it is insulated both from the anode and the tank case. Voltage applied to the grid ionizes the mercury vapor near the face of the anode and thus assists in establishing the power arc.

Rectifier Compounding. The rectifier compounding circuit is shown diagrammatically in Fig. 5. The main power circuits are indicated by the heavy lines and the auxiliary compounding circuits by the lighter lines. As shown on the diagram the twelve-phase

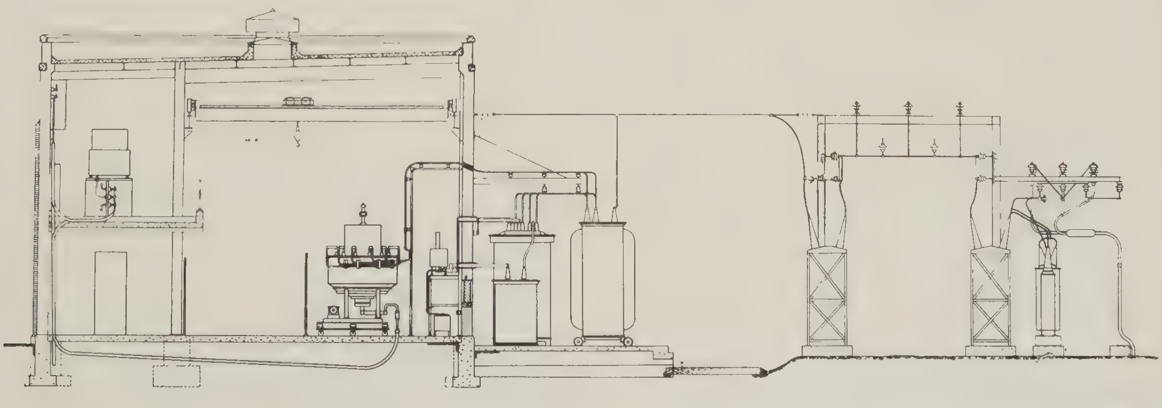

Fig. 2. Transverse sectional elevation of a typical Lackawanna substation showing equipment arrangement

secondary of the main transformer is made up of four three-phase secondaries with their neutrals connected together through interphase transformers.

The compounding is accomplished by shunting the third-harmonic interphase transformers (which connect neutral N^1 with N^2 and N^3 with N^4) by means of two tuned compounding circuits, each containing a capacitor and one winding of a compounding reactor. At very light loads the d-c. voltage corresponds substantially to the voltage of a three-phase rectifier; as load comes on, due to the shunting of the third-harmonic current from the interphase transformer winding through the compounding circuit, the condition approaches more and more nearly that of the six-phase rectifier, which gives approximately 15 per cent higher d-c. voltage with the same a-c. secondary coil voltage. The characteristic curve of one of the Lackawanna rectifiers when running compounded as determined by test, is shown in (a) of Fig. 6. For comparison the characteristic (b) when running non-compounded is also shown.

The power factor of the compounded rectifier unit including the transformer is notably high, showing approximately 96½ per cent lagging at 25 per cent load and increasing with load to 99 per cent lagging at 50 per cent load; at 150 per cent load it leads slightly but drops back to 99 per cent lagging at 300 per cent load. Due to the fact that they are connected in circuits carrying third-harmonic frequency the effect of the compounding capacitors on the power factor is greatly increased.

When compounded rectifiers are run in parallel it is necessary to provide an equalizer bus connected above the compounding reactor as indicated in Figs. 2 and 5, in order to assure equal compounding effect and equal division of the load between parallel units.

Multiple-Unit Car Equipment

The multiple-unit car equipment in the initial electrification consists of 141 two-car units, each unit consisting of one motor car and one trailer car semi-permanently coupled together, with a control position and motorman's cab at each end of each two-car unit.

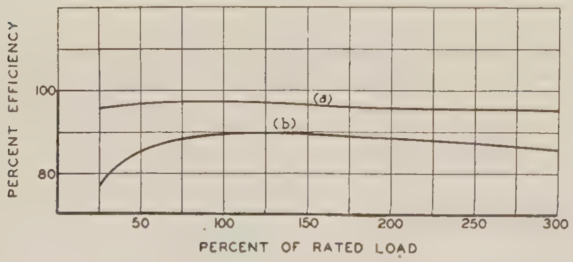

Fig. 3. Comparative efficiencies (including transformers) of (a) D. L. & W. 3,000-volt, 3,000-kw. mercury arc rectifiers and (b) 3,000-kw. motor-generators considered for use in the electrification

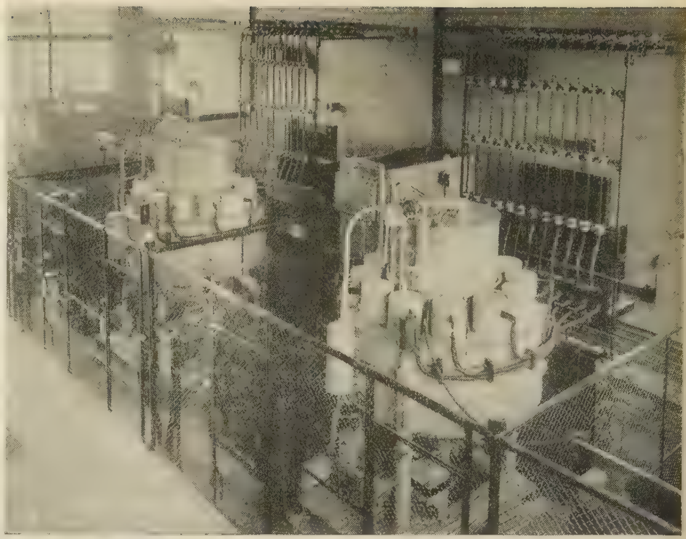

Fig. 4. Typical rectifier installation

Trains of from two to twelve cars are made up by coupling units together, the train control circuits connecting from unit to unit (and from car to car within the unit) by means of jumpers with plug connectors.

All motor cars are new steel cars, 70 ft. 3¼ in. long over bumpers, seating 84 passengers, and weigh, completely equipped, approximately 147,000 lb. without passengers. All trailer cars are remodeled steel cars formerly used in steam service. They seat 78 or 82 passengers, depending upon the type (except combination baggage and passenger cars and club cars, which seat less), are approximately 70 ft. long, over bumpers, and fully equipped weigh from 105,000 to 110,000 lb., exclusive of passenger load. Fig. 7 shows a view of an eight-car train made up of four of the two-car units. An extra express car (not electrified) is hauled on certain trains during non-rush hours.

Motor Equipment. Each motor car is equipped with four motors of 235 hp. (one-hour rating) each, the capacity of the motors being fixed by the requirements of local service with frequent accelerations. The motors are operated with series-parallel connections starting with four motors in series and cutting over to two parallel groups of two in series as the train comes up to speed. All motors, however, are insulated for the full 3,000 volts.

The motors are self-ventilated, using a series pull-push system. The cooling air is taken in through louvers at the top of the car, passes through settling chambers over the vestibules, then down through ducts built into the sides of the car and under the car, then through flexible "pants-leg" ducts to the motors. The air enters the motor at the commutator end through an end-housing connection admitting the air to the armature inside the commutator bell. It is sucked through the armature by the fan on the pinion end of the motor and forced back through the field windings to a discharge port at the commutator end of the housing.

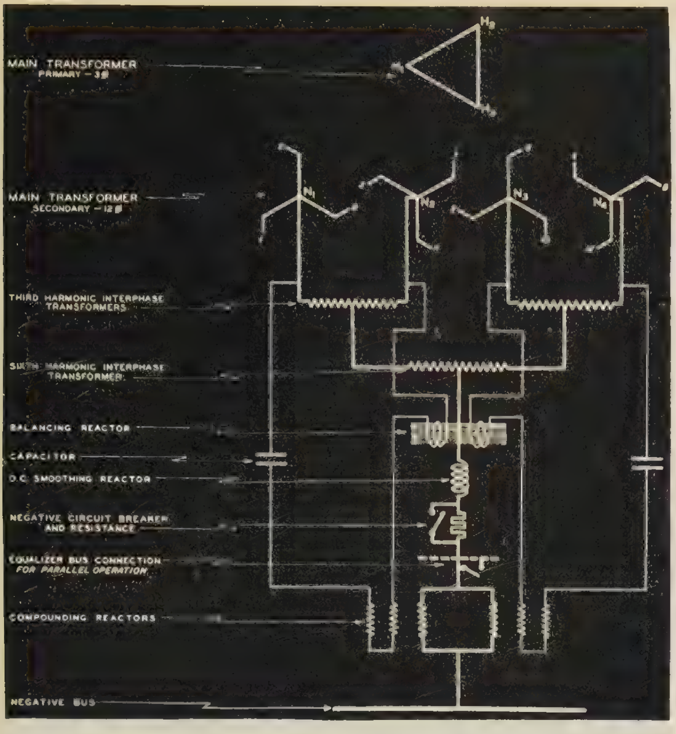

Fig. 5. Simplified diagram of rectifier compounding circuit

Results indicate that this design is effective in keeping the motor free from dirt and snow without the necessity for filtering the air.

Control and Auxiliary Equipment. Each motor car is equipped with two pantographs, only one of which will normally be used at a time. The pantographs have four self-alining roller bearings, are spring-raised and air-lowered, and have a working range of from 15 ft. 6 in. to 25 ft. 3 in. above top of the rail. The standard pantograph has two contact shoes each equipped with two wearing strips with a grease groove between. For comparative purposes, however, 50 pantographs have been provided with single-contact shoes, each with two wearing strips and a grease groove.

The control system operates at 32 volts supplied by a storage battery carried on the motor car. This battery also supplies power for lighting both the motor car and its associated trailer car. A master controller is located in each end of each two-car unit. This control equipment provides for automatic train acceleration of 1.5 mi. per hr. per sec. The balancing speed of a six-car train is approximately 65 mi. per hr.

A dynamotor (with two windings in series) mounted under each motor car provides 1500-volt power for operation of a 1500-volt air compressor, and also drives by direct-shaft connection, a 4-kw. battery-charging generator for charging the control and lighting battery. The dynamotor is self-ventilating, taking its ventilating air directly from beneath the car through a centrifugal air separator.

The air compressor has a displacement of 36 cu. ft. per min., and in the event of failure of one compressor of a two-unit train, is adequate to supply the total requirements of a four-car train with an ample margin of reserve.

Push-button control switches mounted in the operator's cabs provide for controlling the pantographs, the control circuit, the heater circuit, the main-line breaker, the dynamotor, the number and gage lights, and the headlights.

Heaters. Heating on all cars is supplied by totally enclosed resistance-type heaters operated under thermostat control and connected in series on 3000-volt circuits. The wiring for these heaters is shown in Fig. 8 which is a schematic diagram of the entire car circuit. On the standard passenger cars the heaters are mounted under the seats with 40 heating elements in series. The heating elements which are themselves totally enclosed and insulated are supported on porcelain block insulators mounted in steel cases, so designed as to guard fully against the possibility of coming in contact with the heating element. The heater cases and the conduits leading to them are thoroughly grounded. The heater circuit in the trailer car is supplied from its associated motor car by a heater bus jumper on the roof of the cars. There is no 3,000-volt connection between separate units, each unit being entirely independent of the other units in the train except for the control circuits connected through by jumpers underneath the cars and for the air lines which are also connected through.

Car Circuit Protection

All car circuits are protected by one main fuse of a new expulsion, compression type, mounted on the roof of the car, and connected directly to the pantographs. The motor circuit is further protected by a main line breaker consisting of four magnetic blow-out contactors in series and an overload relay. All auxiliary circuits are fed as a group through a limiting resistor of 1.5 ohms (which would limit a short-circuit current to a maximum of 2,000 amperes). Each auxiliary circuit is protected individually by an expulsion fuse, the dynamo circuit having in addition a permanent resistance of 13.5 ohms connected in series.

The main fuse has a continuous rating of 300 am-

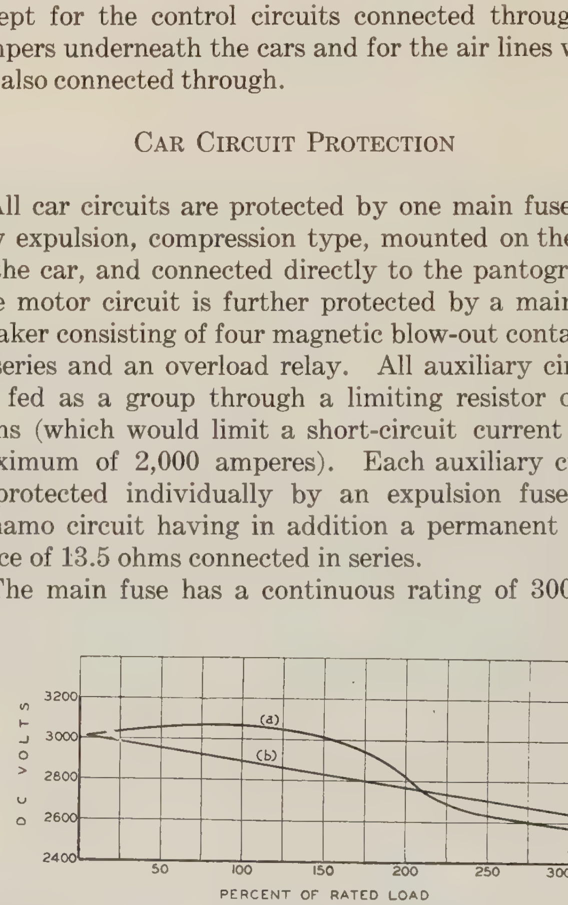

Fig. 6. Rectifier regulation characteristics showing voltage (a) compounded and (b) non-compounded

peres, or 650 amperes for 30 sec. The dynamotor circuit and heater jumper circuit to the trail car are each fused for 20 amperes, and the heater circuits for 8 amperes each.

Fig. 7. Lackawanna suburban train made up of two-car units. Typical overhead construction for curved track also may be seen

Lightning protection is provided on each motor car by an electrolytic aluminum cell lightning arrester with balancing resistor and shunted spark-gap.

Locomotives

Two locomotives of the three-power type shown in Fig. 9 have been provided for handling the freight transfer service between the Secaucus and the Jersey City yards, a distance of approximately four miles. When on electrified tracks, these locomotives operate from the 3,000-volt contact system, and when on non-electrified tracks, on internal power provided by a 300-hp. Diesel engine direct-connected to a 200-kw., 750-volt generator supplemented by a storage battery of 360 cells with a rating of 242 kw-hr. (340 ampere-hours). Each locomotive weighs 248,000 lb. with all the weight on four driving axles, is equipped with four motors of 400 hp. (one-hour rating) each and has a tractive effort of 60,000 lb. Each locomotive is capable of hauling a train of 2,500 tons, trailing load, at a balancing speed of approximately 28 mi. per hr. when operating on external power from the 3,000-volt contact system, or at approximately 12½ mi. per hr. when operating on internal power only. When running light on internal power the locomotive has a balancing speed of approximately 30 mi. per hr.

Distribution System

With two minor exceptions the 3000-volt power for operation of the trains is distributed through the contact system only, without the use of auxiliary positive feeders.

The catenary system is of the tangent-chord type. On main-line tracks it consists of a composite main messenger, an auxiliary messenger and two contact wires. The main messenger has a breaking strength of 31,000 lb. and an equivalent conductivity of 350,000-cm. hard-drawn copper. The auxiliary messenger is 2/0 hard-drawn copper and the contact wires are two 4/0, grooved bronze wires of 55 per cent conductivity. The total equivalent conductivity of the standard main line catenary system is 720,000-cm. hard-drawn copper per track. On yard tracks and cross-overs a lighter system is used with a 7/16-in. bronze messenger and a single 4/0, 55 per cent conductivity bronze contact wire.

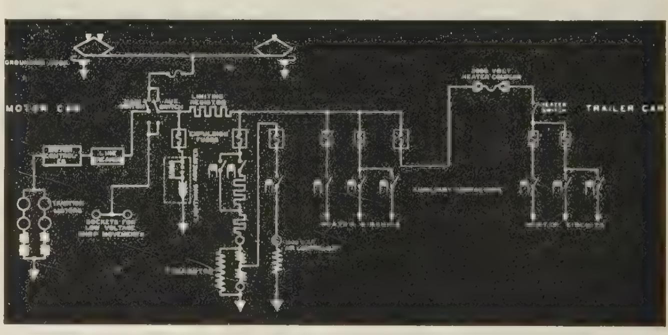

Fig. 8. Simplified diagram of car wiring; note heating circuits connected directly to 3,000-volt trolley circuit

Catenary Supports. Steel catenary supporting structures are used throughout except on the branch line from Summit to Gladstone, which is a single track line on which wood poles with steel brackets are used except at special locations where steel structures are required. The standard steel supporting structure has H-columns and either an H-beam or a latticed truss cross member, the H-beam being used up to spans of 53 ft. and lattice truss for longer spans. On tangent track the standard spacing between catenary supports is 300 ft. In general the signals and catenary system are supported on the same structures which support the catenary, as illustrated in Fig. 10.

Tie Stations and Catenary Sectionalizing. Except on the single track branch line from Summit to Gladstone, tie stations (or circuit breaker sectionalizing stations) are located approximately midway between substations, and also at or near the ends of stub-end lines. The locations of the tie stations and the distances between substations are shown on the map, Fig. 1, already referred to. At the tie stations the catenary system is sectionalized and all circuits are brought to a common bus through high-speed circuit breakers, the holding coils of which are energized from the line. With this arrangement advantage is taken of multiple feed with

reduced copper losses between substations and tie stations without sacrificing selective protection of the line. All tie stations are largely automatic in function but are also under remote or supervisory control from the nearest railroad signal tower. The high-speed circuit breakers connected with circuits which are also fed at the other end from a substation are arranged so that after opening under a line short circuit or overload, they reclose automatically as soon as voltage is restored on the circuit (*i. e.*, when the circuit has been energized from the substation end by the operator at the substation, reclosing the feeder breaker). On stub-end lines which receive power at one end only, the breakers, after opening under short circuit or overload, automatically reclose three times at definite intervals and then lock out if the fault has not been cleared.

The trip points of the high-speed magnetic blow-out circuit breakers are adjustable as to current and also as to sensitivity to the rate-of-rise of the current. New

Fig. 9. Combination trolley-Diesel-battery locomotives used for freight transfer

features of these breakers permit increased flexibility in the rate-of-rise adjustment. Means are also provided for calibrating the breakers with low-voltage battery current (maximum, 20 amperes at 12 volts).

Other Features

In connection with the electrification program a complete change in the signal system became necessary. The signals and track circuits were formerly battery-operated and the signals throughout most of the territory electrified were of the old semaphore type. All signals in the electrified zone have now been changed to colored light signals with a-c. track circuits. Impedance bonds are provided in the tracks at all signal locations. At all other points the standard track bonding consists of a single 4/0, 8½-in., gas-welded, stranded-copper, steel-terminal, U-bond at each joint on each rail.

Extensive surveys and tests were made both before and after electric operation of trains was begun to determine the points at which there might be danger of electrolytic damage to underground cable sheaths and other metallic structures, and drainage cables have been installed where they were found desirable.

Where necessary to provide adequate physical clearance, communication circuits located along the right-of-way, consisting of the railroad's communication lines and some other telephone and telegraph lines, have been moved or put into cables. Inductive interference from the d-c. power flowing through the catenary system has been practically eliminated by the use of twelve-phase rectifier transformers, d-c. smoothing reactors and resonant shunts, installed at the substations.

The mercury arc rectifiers also cause a distortion of the wave form on the a-c. supply circuits, and where the a-c. power is supplied by overhead transmission lines inductive interference in neighboring telephone circuits may be experienced unless steps are taken to guard against it. This effect can, however, be largely eliminated by proper coordination and transposing of the power circuits and the neighboring telephone circuits. This has been taken care of by the cooperative effort of

Fig. 10. Typical overhead construction on a three-track tangent section

the power companies and the telephone companies. No radio interference has been reported.

This is the first electrification program attempted in this country in which the entire power supply for tractive purposes depends solely on the satisfactory

performance of mercury arc rectifiers. Such a project would have been impossible of completion in this way had it not been for vast improvements in the design of these devices which enable them to be built for higher voltages and heavier loads than heretofore. These advances have been made possible by the intensive research and development work which has been applied to converting apparatus in general during the past few years. The installation of such a system constitutes a bold step forward in the electrification field, and its effect on future projects of this sort will be watched with keen interest.

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Your Nimble Servant —the Electron

A summary of the present scientific understanding of electronic theory presented briefly in non-technical language.

By Karl Taylor Compton

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THE ELECTRON, as is commonly known, constitutes the smallest known division of matter. Science has shown it to be a peculiar combination of mass (minute though it is) and electrical charge, and that its inherent characteristics exhibit a singular combination of rotation and wave motion. All electrical phenomena are directly dependent upon the workings of countless numbers of these infinitesimal particles. A stream of them flowing along a wire constitutes a flow of electric current; millions of them boiling off hot metal filaments give us modern radio and the talkies; still more millions of them are active in our luminescent electric signs, while television is providing still another job for these "nimble servants."

In 1899 experiments on the striking luminous and electrical effects accompanying the discharge of electricity through vessels containing gases at reduced pressure led to the discovery that in these phenomena, the primary agent which we now know as the electron is a negatively electrified particle 1,846 times lighter than the lightest entity then known, the hydrogen atom, and bears an electric charge which is a natural indivisible unit of electricity. Electrons are affected in various ways by a wide variety of agencies, such as heat, light, chemical action, and shock. In some cases they are ejected from bodies spontaneously; in other cases they are pulled out by intense electrical fields. Spontaneous emission of electrons is one of the three phenomena shown by radioactive substances, and it occurs in the process of actual transmutation of one chemical element spontaneously to another.

These properties of the electron were discovered by Sir J. J. Thomson and his pupils immediately following the year 1899. About 12 years later Millikan and his pupils made much more accurate measurements of the magnitude of the electric charge on an electron. As a result of this work it may be said truly that although no one ever has seen or ever will see an electron, and although it is the smallest charge and has by far the smallest mass of anything which is known, nevertheless its mass and its charge have been measured experimentally with an accuracy far beyond that with which materials ordinarily are weighed or measured.

Magnetic Properties

Light produced by the motions of electrons in atoms has been found to be affected in a peculiar way by the presence of a magnet. By means of a magnetic field the light which may be given out at a certain definite wavelength and appear as a certain definite color or line in the spectrum may be split up into several components, some of longer and some of shorter wavelength, and having peculiar properties of polarization. This effect is so small that it can be observed only under the influence of powerful magnetic fields; and even then it is so small that it must be examined with a magnifying glass. This phenomenon is known as the "Zeeman effect." It has led to the proof that an electron, besides being an electric charge, also is a tiny magnet of perfectly definite strength, and that therefore the electron may be oriented one way or another by the application of a magnetic field.

Magnetic effects are produced, of course, by electric currents and any circuit in which an electric current is flowing behaves like a magnet. This suggests that every electron is really a tiny electric circuit; or, in other words, that it consists of a rotating or revolving electric charge the revolution of which is equivalent to a current in an electric circuit. This suggests that the

From an address delivered at a special session of the A. I. E. E. winter convention, New York, Jan. 28, 1931.

electron is a spinning electric charge, and therefore that in addition to having mass and electric charge, it has a definite magnetic moment and an angular momentum.

Wave Properties

The electron also has the properties of a wave. The phenomenon of interference is widely known as characteristic of all types of wave motion, including light, heat, ripples, elastic vibrations, radio waves, and similar phenomena; but G. P. Thomson, son of Sir J. J. Thomson, was the first to show that when electrons pass through tiny apertures, there are phenomena of interference exactly similar to the phenomena of interference occurring when light passes through similar small apertures. This is perhaps the most striking demonstration of the fact that an electron has the properties of a wave. The same conclusion had been reached by a different interference phenomena a short time earlier by Dr. Davisson and Dr. Germer of the Bell Laboratories.

This wave nature of the electron is of a peculiar kind, in that the wave appears to be associated with it, directing it in its motion. There is a sort of indeterminism in the motion of any individual electron, but the probability or statistical likelihood of definite direction of motion can be determined from the properties of the wave which is associated with it. The wave furthermore has the peculiar property of a wavelength varying inversely as the momentum of the electron.

Current Flow Explained

Long before the existence of electrons was suspected it was found that the amount of current flowing in any given metallic circuit was exactly proportional to the voltage. This is the relationship as stated in the familiar Ohm's law. From the scientific standpoint it has been of great interest and until recently, a great puzzle as to just what determined this proportionality between current and voltage. According to the presently accepted ideas the more loosely bound electrons in the atoms which make up the metal are, under the influence of neighboring atoms, detached from their original parent atoms and are free to move somewhat at random throughout the metal. This motion is governed in part by temperature, since, on the average, the higher the temperature the more rapidly these electrons will move. The motions of the electrons are not all alike in velocity or direction, but are distributed at random according to a certain law of probability given by what is known as the Fermi statistics. These electrons are interfered with in their motion in various directions by collisions with each other or with atoms. When a voltage is applied, however, there is a constant force impelling them on the average to drift in the direction of the voltage, and it is this drift which constitutes the electric current.

In the earlier theories, the collisions just referred to were conceived of as if with atoms which behaved like hard, resilient spheres; but this was obviously too crude an approximation to fit the facts; an apparently satisfactory picture is the recent one credited to Sommerfield and his pupils, according to which the motions of electrons in metal are governed by the interference of their waves in passing through the lattice-like structure of the atoms. According to this idea the deflection of an electron at collision means simply that the electron wave has been bent or diffracted out of its original path.

All this has brought about a very close analogy between some problems in electrical conduction and some problems in the propagation of light; and underlying this whole subject is a new branch of mechanics called "quantum mechanics." According to quantum theory, mechanical or electrical phenomena involving particles of electronic or atomic dimensions have to be treated by "wave mechanics," whereas phenomena occurring between larger bodies of a tangible size are treated by the ordinary electrodynamical methods; in other words, ordinary electromechanical concepts represent the special form which the quantum mechanics takes when applied to large bodies.

Electron Motion in Gases

Conduction of electricity through gases, which was the phenomenon that originally led to the discovery of the electron, still supplies perhaps the most complicated and intriguing problems in electricity. In such phenomena there must be considered the electron which is moving rapidly under the influence of the applied voltage and making frequent collisions with gas molecules; there must be considered also the heavy positive ions which result when electrons are knocked out of molecules, and which move relatively sluggishly in the opposite direction. Due to concentrations of one or the other kind of these electric charges in different parts of the gas, there is produced a very irregular distribution of the voltage through the gas, which accounts for some of the striking optical and electrical peculiarities of gas discharges.

Another peculiarity of electric currents in gases is that as the current increases, the resistance of the gas decreases. Because of this fact electric currents in circuits containing a path through a gas show many remarkable peculiarities, such as electric oscillations and discontinuous changes. Familiar forms of these phenomena include sparks, electric arcs, and the great variety of sign-lighting devices, such as neon tubes and mercury arcs. Lightning and aurora borealis are examples of such currents in cosmic phenomena.

Another interesting phenomenon is the thermionic emission of electrons. As already mentioned, the average speed of electrons in metals is controlled by the temperature of the metal, and if this temperature is

raised sufficiently high an appreciable proportion of the electrons which strike the surface of the metal from the inside will be moving fast enough to escape entirely from the surface in spite of forces which tend to pull them back. It is these evaporated electrons which constitute the electric currents in radio tubes. There the hot filament is the source of electrons which are evaporated into the surrounding space and are drawn to the plate subject to the controlling action of the voltage impressed upon the intervening grid.

Electrons Respond to Light

When light, particularly ultra-violet light, falls upon metals, electrons may be ejected from the metals. The stronger the light the more electrons are ejected; and the shorter the wavelength of the light the greater the velocity with which they emerge. This phenomenon was accidentally discovered nearly 50 years ago, although its exact nature was not then understood. One of the most important contributions which Einstein has made to science was brought out in 1905 in his application of the quantum theory to explain the relation between the wavelength of the light and the velocity of ejection of the electron.

At the present time these so-called photoelectric currents are perhaps the most sensitive means in existence for the detection of light. They are used in stellar photometry and are the heart and soul, so to speak, of all television apparatus. This photoelectric phenomenon, too, is capable of a great variety of applications. For example, it permits electrical registration to be made of visitors entering a door; it permits automatic sorting of cigars, fruit, cloth, or other objects according to color; it enables the U. S. weather bureau to make a continuous electrical record of the brightness of sunlight; it performs innumerable important laboratory functions.

The Electron in Chemistry

A most interesting series of lectures was delivered at the Franklin Institute in Philadelphia a few years ago by Sir. J. J. Thomson concerning the electron in chemistry. It has become evident now that the so-called "chemical forces" or valence forces which the chemist has used to account for the sticking together of atoms to form all the multitudinous varieties of molecules are nothing more or less than electric and magnetic forces existing between atoms and caused by the space distribution motion of electrons. Thus the whole field of chemistry on the interpretive side is turning into a study of electronic effects.

One of the most effective ways to investigate any object which cannot be seen or handled is to stir it up in some way and then try to observe and interpret what happens; this is exactly the process of research in modern atomic physics and interpretive chemistry. Atoms and molecules can be stirred up in a variety of ways—by heat or by electrical currents. Emission of light is the most frequently observed result of such agitation and from a spectrum study of that light it is possible to infer a great deal as to what went on in the atoms and molecules themselves. In principle this method has been the basis of all present knowledge of the structure of atoms and molecules and the fundamental electrical nature of matter.

Fundamental to, and inherent in, every aspect of mechanical and electrical properties of matter, there is the electron—always present and always active, and thus justifying perhaps the title of this article, "Your Nimble Servant, the Electron."

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Reducing Noises From Power Transformers

With a view to their reduction, objectionable noises have been under investigation in various parts of the country during the past few years. In line with such work, thoughtful attention is being given to the reduction of unnecessary noises in electrical machinery and apparatus. Causes of transformer noises have been determined and together with means suggested for control are described here.

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VIBRATION is the chief cause of the noises emanating from power transformers, since rotating parts, the most prevalent sources of noises in all machines, are completely absent. Electromagnetic pulsations set up by the alternations of the current in transformer windings give rise to mechanical vibrations. An impulse from each half-cycle of this current causes a fundamental frequency of vibration double that of the circuit in which the transformer is connected. Thus the

From "Power Transformer Noise, Its Characteristics and Reduction" (**No. 30-178**), presented at the A. I. E. E. Southern District meeting, Louisville, Ky., Nov. 19-22, 1930.

fundamental frequency of vibration in a 60-cycle transformer would be 120 cycles per second. These vibrations usually originate in the core-and-coil structure and are transmitted by the oil to the tank wall whence they are passed on into the outside air. Resulting sound emission is in the nature of a continuous hum of comparatively definite pitch and in most cases extremely annoying.

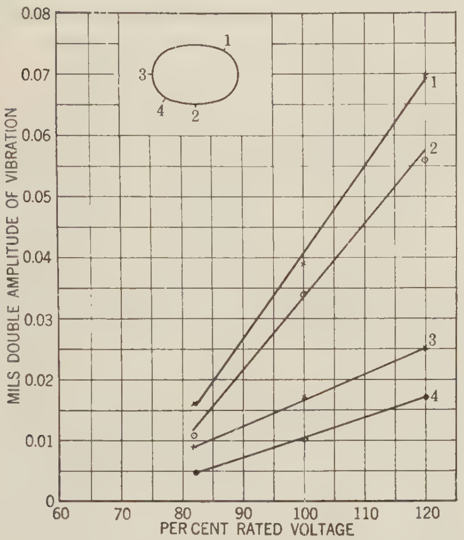

Fig. 1. Effect of voltage variation upon amplitude of transformer tank-surface vibration

Results of a theoretical investigation made to determine the different force components in transformers which might cause vibration show that:

1. The force between the winding and the core is an attractive force, but when solid insulation is wedged in between the coils and core, this force is not serious.
2. There is an attractive force which acts at each joint of the core and tends to make the iron circuit continuous; this force is directly proportional to the cross-section area and to the square of the magnetic density.
3. There are between parallel laminations of the core, forces of repulsion arising from like poles induced in adjacent ends of parallel laminations.
4. There are electrodynamic forces between the coils. These forces are attractive between coils of the same winding and repulsive between coils of different windings. They are proportional to the square of the ampere-turns per group.

In addition to the forces just enumerated, metal plates, tie rods, radiator tubes, structural steel parts, or other members, may be resonant and serve as unexpected sources of noise which are sometimes exceedingly troublesome. Power transformers having tanks with large areas exposed for radiating sound, however, usually have natural periods of vibration below 60 cycles.

To deal effectively with the noise problem, the sound analyzer developed by J. P. Foltz ("Study of Noises in Electrical Apparatus" TRANS. A.I.E.E., July 1929) was used in these investigations. The instrument consists principally of amplifiers and filter circuits which can be set to eliminate all but a certain frequency. The noise to be analyzed is picked up by a microphone and passed through the filter circuits. The setting of the filter-circuit condenser indicates the frequency of the sound measured, and a meter indicates in dynes per sq. cm. the intensity of the sound at that frequency.

For comparing sounds with reference standards, this analyzer is independent of the human ear and therefore leaves nothing to the personal judgment or imagination of an individual listening to a telephone receiver. When it is desired to measure mechanical vibration, a calibrated phonograph pick-up is substituted for the microphone; then the sound analyzer can be used to measure the frequency and amplitude of vibration.

Vibration amplitude and frequency measurements were made on the tank surfaces and core-and-coil parts of a number of representative sizes of completely assembled transformers at no-load and at different voltage values. These tests were to determine the effect of line voltage regulation on the amplitude of vibration and the corresponding sound intensity. Fig. 1 shows some of the results of tests on a large transformer at the elevation of the center of the core; locations of the points are indicated on the plan view at the upper left hand corner of the figure. These curves are approximately straight lines, indicating that the vibration component due to voltage regulation can be considered directly proportional to the per cent change in line voltage within the operating range of the transformer. The ratio varies with different designs but is usually of the order of 30 per cent change in sound intensity for 10 per cent change in primary voltage at no-load.

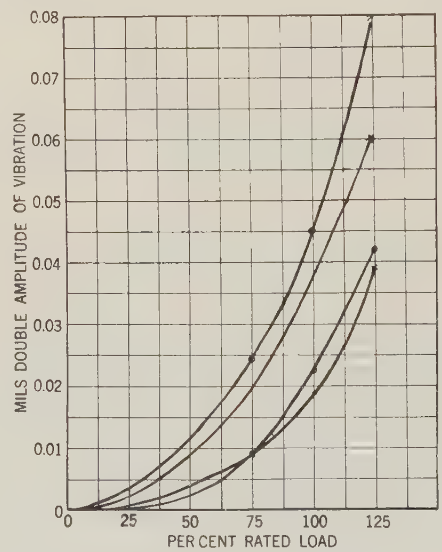

Fig. 2. Effect of load current upon amplitude of transformer tank-surface vibration

Tests were made also on the core-and-coil parts of transformers to determine the characteristics of those parts which act as sources of noise due to load currents in the windings. These tests were made with one

transformer winding short-circuited and sufficient voltage impressed on the other winding to obtain the desired values of load current. Vibration amplitudes and frequency measurements were taken for each load. There were similar tests on completely assembled power transformers where surface vibration measurements were made also on the tank and other exterior surfaces. Results of tests on one of these transformers are shown in Fig. 2. Measurements were taken at four representative points at different elevations on the side of the transformer. It may be observed that the amplitude of vibration varies approximately as the square of the load current.

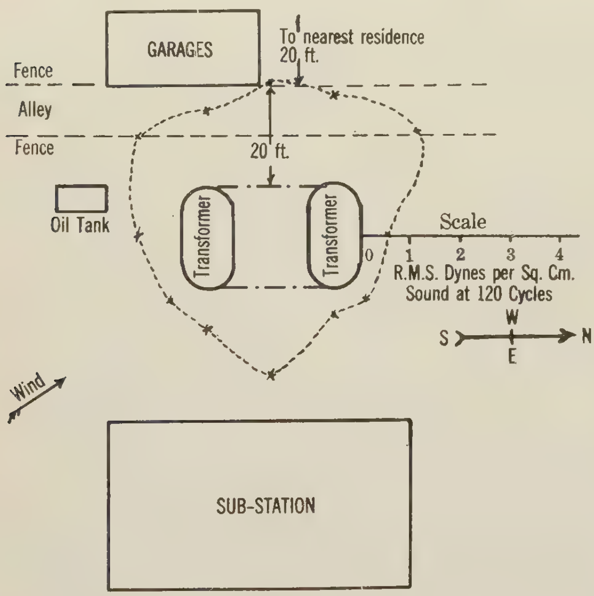

Fig. 3. Intensity distribution of 120-cycle sound measured at points 20 ft. from transformers. Reflections from nearby buildings and effect of wind may be noted

Results of frequency analyses at the points of maximum amplitude of vibration observed on the load and voltage tests showed that different harmonic frequencies were present under both sets of conditions. All of these harmonic frequencies were exact multiples of the 60-cycle power frequency. However, vibration amplitudes at frequencies above 120 cycles were usually so small as to be negligible. The test range included frequencies up to 3,000 double vibrations per second, but no vibrations were noted at frequencies above 600 cycles.

Another investigation was made to determine the distribution of sound at 120 cycles measured at a distance of 20 ft. from the transformers at the substation shown in Fig. 3. Since there are two transformers at this station, lines were drawn between them, and the resulting area treated as the noise source. The curve is plotted in modified polar form with reference to the tank wall and the two connecting lines described above. At a distance of 20 ft., the average vibration intensity was found to be 1.142 dynes per sq. cm., the minimum 0.48, and the maximum 2.06. This results in a maximum-to-minimum ratio of 4.3 to 1. Reflections from the substation building and the neighboring garages are evident, as is also the effect of wind, in the upper right hand corner of the figure. Both transformers were large three-phase units, carrying at the time of test about 84 per cent rated load at about 97 per cent rated voltage.

Fig. 4 gives another interesting illustration of the effects of the acoustic conditions at the substation; a smooth-finish, plastered wall was located diagonally as shown on the upper side of the figure and a hard wall of steel plates was located symmetrically on the opposite side of the transformer. The inner curve shows the distribution of vibration of the tank wall at 120 cycles; the outer curve shows the distribution of the intensity of sound at 120 cycles and at a distance of 42 in. from the tank wall. Both curves are plotted in modified polar form with reference to the tank wall. The average 120-cycle intensity was observed to be 0.385 dynes per sq. cm., the maximum 0.685, and the minimum 0.31, giving a maximum-to-minimum ratio of 2.2 to 1.

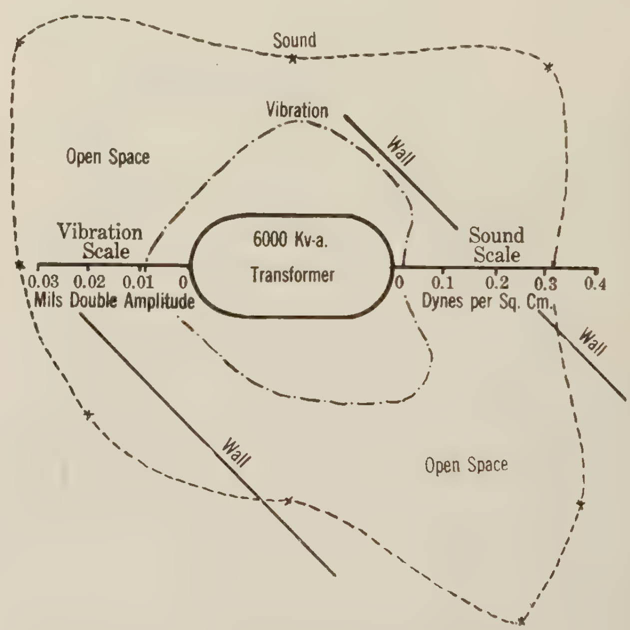

Fig. 4. Curves showing the effect which enclosing walls have upon the intensity distribution of 120-cycle sound from a transformer

Conclusions

These surveys mark an important advance in the knowledge of power transformer noise characteristics and magnitudes. The sound intensities are not uniform in all directions, the acoustic conditions at the substation playing an important part in the final distribution of sound.

The very nature of a transformer makes it always

produce some hum, but for operation near hospitals or in residential districts this hum can be reduced by the following expedients:

(1) Using additional iron in the core in order to secure low magnetic density. This also means additional copper and a more expensive transformer.

(2) Stiffening the bracing and supporting parts to reduce vibration and in some cases adding damping devices to change the natural period of vibration.

(3) Adding cushions or padding between parts of the transformer.

(4) If sufficient area is used to prevent crushing, cork pads can be used under transformer tanks in indoor vaults. Arbors, hedges, shrubbery and trees are very effective for absorbing sound from outdoor substations.

What of Surplus Power?

Surplus power, natural by-product of the electric service industry, should be developed and utilized in industrial processes under a definite program. A plan is proposed whereby the useful output of existing electric generating equipment may be increased as much as 30 per cent; improvement resulting in system load factor would permit economic construction of plants still more efficient, thus contributing constructively to the cycle.

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Fellow A. I. E. E.

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MANY ATTEMPTS have been made to dispose of seasonal and off-peak power, but thus far the only reasonably successful scheme brought out is interconnection. This plan, however, reacts more toward the saving in reserve generating equipment than in the transfer of energy. The proposal for the utilization of surplus power as introduced in this article differs from others in that the rate of power supply is under the control of the power company, and as the total system load demands can be varied at will. Surplus power can be used in this way for a number of electrochemical and electrothermal processes and will result in markedly reduced costs for a great many commodities. For example, it is possible to manufacture illuminating gas at a cost that would compare favorably with the cost of natural gas at the end of a long pipe line.

For the purposes of this article, surplus or off-peak power will be defined as all power producible from the serviceable capacity of generating equipment that is not required to meet all other demands. The part of this surplus required for the proposed disposal is that portion which would result from the daily generation of a quantity of the surplus energy agreed upon as being available and usable.

Before the proposal has value, the utilities must agree that they have and long will continue to have this spare capacity available. They must assure themselves that the shape of the annual load-duration curves, which has not changed materially during 30 years except as to growth upward, is not likely to change its characteristic shape during the next 20 years. They must be assured that the day of maximum output, which is the main limitation, will continue to have the characteristic load curve which has been typical of the past 20 years of growth.

To avoid complications hydroelectric power is eliminated from consideration. Whenever kw-hr. can be stored in a reservoir the proposal is not attractive; but if steam reserves are needed, the situation becomes favorable.

Possible Rate Reduction

This surplus obviously is nothing but a potentiality; it is not demanded and it cannot be sold under existing terms and conditions; or if it is to be sold or profitably used, the terms must be modified to meet the new conditions. In fairness to the utilities, however, it will be necessary to state that never before have they been called upon to deal with the matter in any like manner or under the conditions proposed in this discussion.

If assumed premises are right and the conclusions are in accordance with the facts, the price of this surplus energy can be made sufficiently low to attract the attention of many possible users most of whom cannot avail themselves of it without becoming purchasers of quantities of the regular high-priced product. The proposal holds out no hope for an early reduction in standard rate schedules, a general reduction of which

will come when the use of this surplus has so increased the capacity-use of equipment that more efficient and cheaper generating plants can be built.

During the early stages of development, it is essential that every cost advantage maturing in favor of the surplus generation should be accredited to it. For example, assume that a purchaser of surplus energy asks for 192,000 kw-hr. per day on a 20-year contract, and will allow the utility to vary at will the rate of delivery between 0 and 10,000 kw. Nine out of ten utilities having a maximum yearly peak of 100,000 kw. or more can meet this requirement and establish a new increment fuel rate about 5 per cent lower than their normal rate.

Some advantages of this plan are:

1. It would be unnecessary to operate or maintain reserves within the capacity of the superimposed load. It is obvious, therefore, that no part of the generating plant capital is involved in the supply of this surplus energy.
2. A regulable means would be provided for setting the total station load nearer to the point of greatest economy.
3. A means would result for absorbing the fluctuations of the normal load.
4. The load factor of the system would be increased.

The actual cost of this energy, when, as, and if generated, is the total production cost for any given

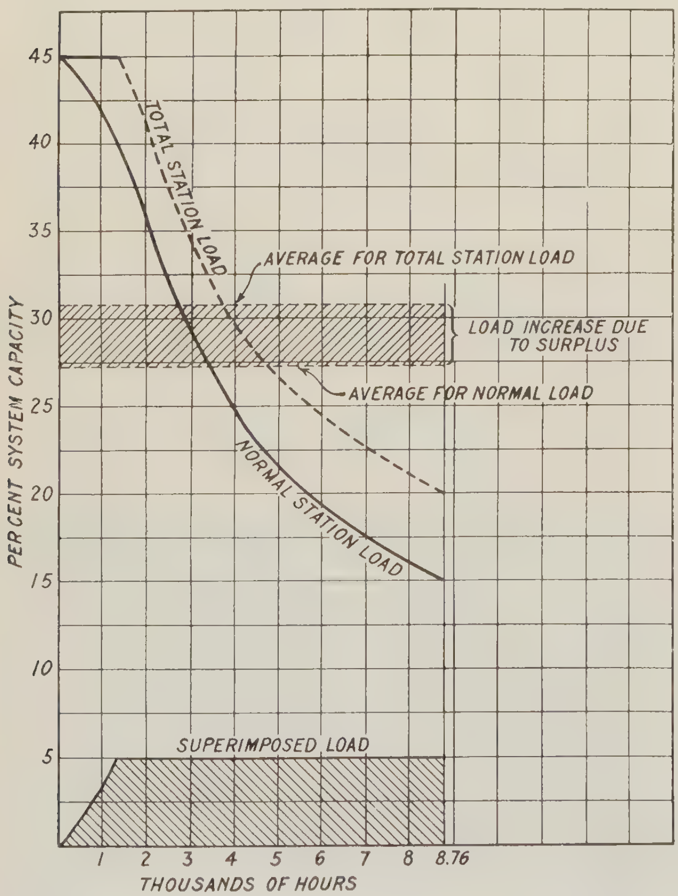

Fig. 1. Cumulative annual curves showing method of superimposing "surplus" load upon normal station load without increasing station demand

period less the estimated cost during the same period for the other or normal load. There may be some difficulty in devising an accounting system to satisfy public service commissions, although it is expected to indicate costs which will provide sufficient latitude for the satisfaction of all concerned.

Surplus Power Now Available

Magnitude of the proposal can best be appreciated by calling attention to a few statistics for 1930 and estimates for 1940 with the trend discounted by reason of the existing depression.

According to statistics, there was installed in 1930 in the United States, a total steam-electric generating capacity of approximately 30,000,000 kw. in stations having a yearly output of about 60,000,000,000 kw-hr. During the period from 1900 to 1930 the maximum-load demand has increased seven times and the annual power output eleven times. On the basis of these facts it seems reasonable to predict a total installed steam-electric generating capacity of at least 45,000,000 kw. by 1940, and an annual power output of 100,000,000,000 kw-hr.

According to the calculations upon which this proposal is based, surplus power could be produced profitably on the basis of an annual output of at least 30 per cent of the present annual output; this means an output of 18,000,000,000 kw-hr. based upon 1930 statistics, and 30,000,000,000 kw-hr. based upon 1940 predictions.

Table I gives data for a suggested annual distribution of load by which this 30 per cent of surplus power can be furnished. Resulting improvement in load factor also is shown. It may be noted that according to this set-up the power is made available for 8,540 hr. out of a total of 8,760 hr. in the 365 days of a year. This arrangement provides for shutting down the surplus power supply during very high peak loads so that the maximum demand on the system is not increased.

TABLE I—SUGGESTED DISTRIBUTION OF LOAD FOR FURNISHING 30 PER CENT SURPLUS POWER OUTPUT

	1930		1940	
	Annual Service hours	Surplus power output in kw.	Annual service hours	Surplus power output in kw.
1st 5 per cent	8,540	360,000	8,540	600,820
2nd 5 per cent	8,322	380,500	8,322	634,200
3rd 5 per cent	8,059	403,000	8,059	671,500
4th 5 per cent	7,708	428,000	7,708	713,340
5th 5 per cent	7,271	457,200	7,271	761,040
6th 5 per cent	6,745	463,200	6,745	815,390
Normal load factor	0.225		0.254	
Load factor with 30 per cent surplus power	0.263		0.329	

In Fig. 1 is shown how this surplus load would be superposed on the normal system load for a typical power system. Fig. 2 shows how the load might be distributed

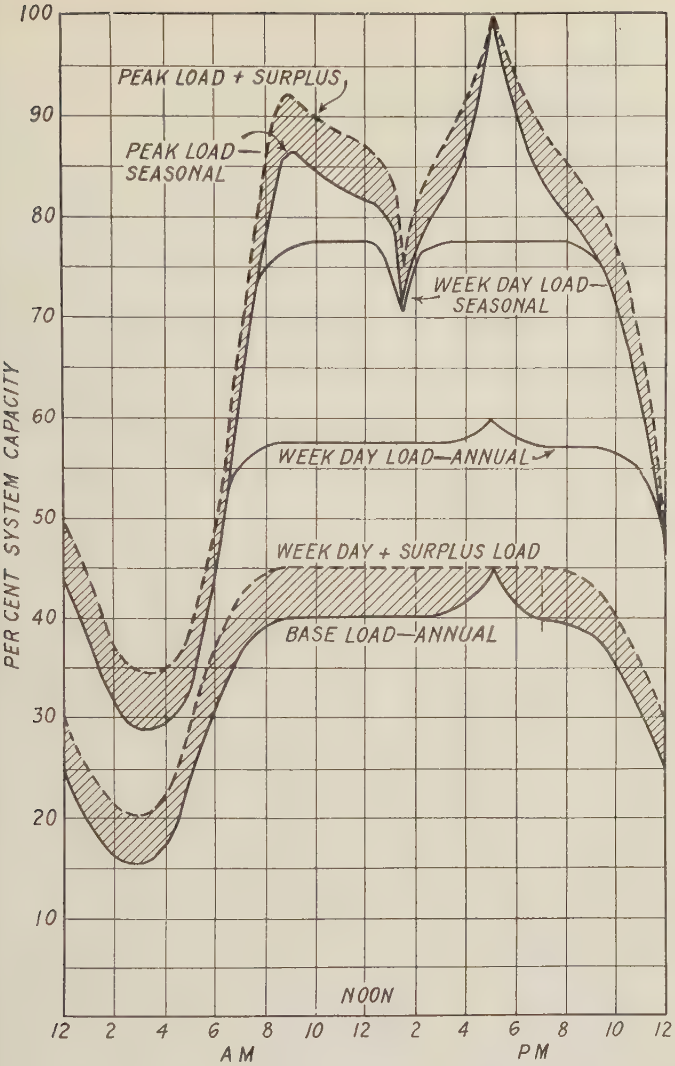

Fig. 2. Typical distribution of annual system peak load among system generating stations showing method of carrying "surplus" load in addition

among the various generating stations of a typical system, and also the cutting off of this load during system peak hours. The greater part of the surplus will be furnished from the most efficient apparatus whose capacity factors will be materially increased.

Base-load apparatus now operating at from 50 to 60 per cent load factor then will operate at from 70 to 80 per cent, a loading that will make it possible to revolutionize the design of generating plants. There will be no question about the advantages of high pressures and temperatures, steam extraction and reheating, and the leviathan prime movers no longer will be needed to save space and meet the conditions of variable load. This should make it possible to standardize the generating equipment and promote quantity production with a tremendous saving in development costs.

It is possible to forecast generating plants of relatively simple design with one steam generator for each prime mover and with most of the equipment in the open air. It is reasonable also to anticipate the use of the double thermodynamic cycle. The mercury boiler and turbine may no longer be a curiosity and there may be competition from other high-boiling-point liquids having suitable vapor tensions.

Those who can remember the "modern" power plants of 1900 with its wonderful performance of 4 lb. of coal per kw-hr., and who know that during the last decade the coal rate of the latest equipment has dropped from 2 to 1 lb. per kw-hr., will not condemn the suggestion that it may be 0.5 lb. per kw-hr. by 1940.

Production Costs

Relative to what this surplus energy will cost, it is but fair to state that several complications are to be faced. Familiarity with hundreds of computations, some of which are based on most reliable data, compels the conclusion that no two plants will produce similar results. The best that can be done is to portray what is considered to be an average. Systems most favorable to the surplus load will have costs averaging lower, and those unfavorable will have costs higher than those to be given.

It is axiomatic that the first 5 per cent addition of surplus will produce the greatest immediate saving, also that the saving will increase proportionally with an increase in the cost of coal. Additional increases in surplus load produce less and less saving until a point is reached where by reason or lower capacity-use the increase in the cost of fuel offsets the efficiency increase.

Admitting the pictorial method used in dealing with a matter requiring knowledge of many local conditions for any real accuracy, what are considered to be average costs are tabulated for the 18,000,000,000 kw-hr. available in 1930 and the 30,000,000,000 kw-hr. to be available in 1940. Assumptions upon which Table II is based are as follows:

1. Coal of 13,000 B. t. u. per lb., at $4.00 per ton.
2. Coal cost is 80 per cent of the total production cost.
3. The actual cost is 110 per cent of the production cost.
4. All fuel saving on normal load is credited to the surplus load.
5. Charges for capital are omitted.

TABLE II—ESTIMATED COST OF SURPLUS POWER COST IN MILLS PER KW-HR.

Surplus	1930	1940
1st 5 per cent	0.4	0.25
2nd 5 per cent	0.6	0.35
3rd 5 per cent	0.9	0.50
4th 5 per cent	1.5	0.75
5th 5 per cent	2.3	1.25
6th 5 per cent	3.5	2.00
Average for 30 per cent	1.5	0.85

Assuming that this portrayal will appear incredible matters may as well be made worse by suggesting that if

by 1940 there is in use some 5,000,000 kw. of double-cycle apparatus, the first 10 per cent addition of surplus will be free of cost, and the average cost for the 30 per cent surplus will be less than 0.5 mill per kw-hr. It should be pointed out that there is a somewhat perplexing question regarding fixed charges for new and possibly more expensive equipment, such as the mercury-cycle boiler and turbine. This more efficient apparatus might be warranted by the surplus, but not by the normal load. Some attempt has been made to allow for this in the table of costs.

How Surplus Power Can be Used

As previously mentioned, this proposal is based upon the absorption of surplus energy in electrochemical and electrothermal processes. Electrochemical processes will come first since they are adapted to the requirement of regulation and of intermittent use. Electrothermal processes are best adapted to the use of night and week-end power. There are but few electrochemical processes now capable of adaptation to this kind of use and only one of them is immediately ready. There is much to warrant the expectation that when the advantages of this cheap power become well known, a way will be

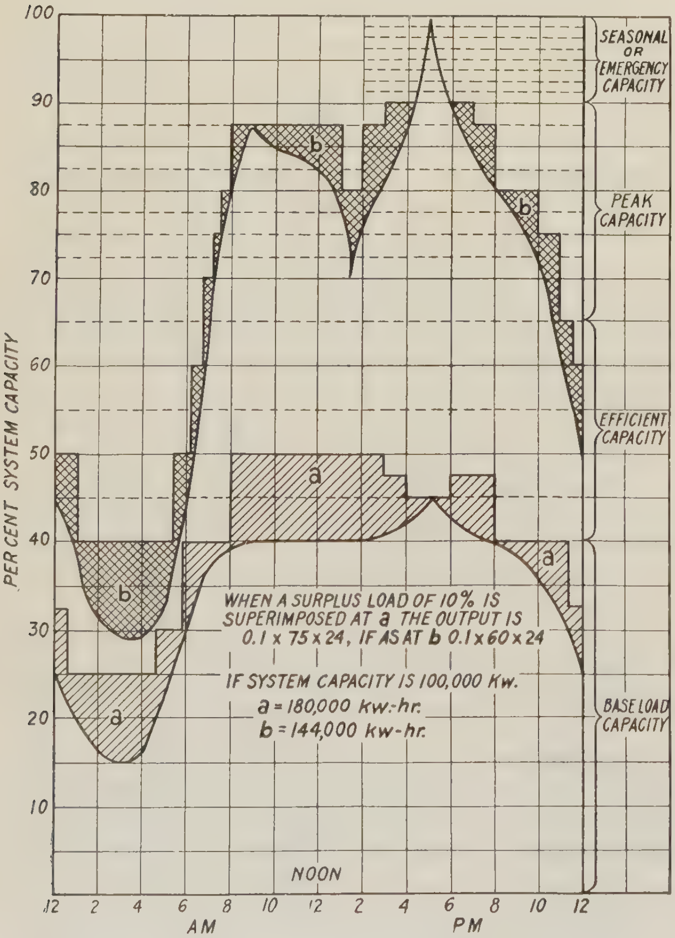

Fig. 3. Method of improving station efficiency by superimposing a "surplus" load equivalent to 10 per cent of the system capacity

found to adapt many more processes to its use—at least to some extent.

Electrolytic cells for the decomposition of water by electric current have been in use for many years. There are several types that will meet the technical requirements of intermittent and variable use of energy. In addition, there is reason to believe that salt cells equally suited to the use of off-peak power will be available shortly. From an economic point of view, first cost and maintenance are of great importance and this narrows the choice of types of cells. However, a careful survey of all types of cells capable of using off-peak power leads to the conclusion that water cells will be of greatest value, salt cells next in value, and that there are other possibilities relating mostly to the electrolysis of organic compounds.

Cost of Many Products Reduced

Without reaching very far into the field of synthetic chemistry and by just touching upon the metallurgical possibilities, a hasty survey reveals some of the possibilities, for it is certain that no matter how great the quantity nor how cheap this surplus energy may be, it will not be used unless profit results. Assume that the materials of manufacture available are air, water, coal, salt, oil, off-peak energy, and energy at standard rates. As products then:

1. Nitrogen can be obtained from air by burning out the oxygen with hydrogen.
2. Water and off-peak energy will produce hydrogen and oxygen.
3. From coal will be obtained pure carbon, carbon monoxide, and carbon dioxide. By use of the coke oven, coke and many hydrocarbon by-products can be made.
4. Salt and off-peak energy will produce chlorine, caustic soda, and hydrogen.
5. From oil, gas and many hydrocarbons can be manufactured.

Well-known chemical processes and usable catalytic reactions are available to convert these materials into a variety of products which can be used in the district in which they are made. Many of these dependent industries will be new to the district, bringing to it an increase of population; all will require more or less power at the standard rates.

The list of products possible of manufacture is too formidable to be reproduced here; by way of illustration only a few are mentioned. Costs given represent the total estimated manufacturing costs:

1. Hydrogen at 20c. per M. cu. ft.
2. Oxygen at 20c. per M. cu. ft.
3. Nitrogen at 15c. per M. cu. ft.
4. Carbon monoxide at 20c. per M. cu. ft.
5. Carbon dioxide at $5 per ton.
6. Chlorine gas at 0.5c. per lb.
7. City gas of 560 B. t. u. at 25c. per M. cu. ft.
8. Caustic soda at $20 per ton.
9. Carbon black at 3c. per lb.
10. As examples of final products may be mentioned synthetic ammonia and city gas.

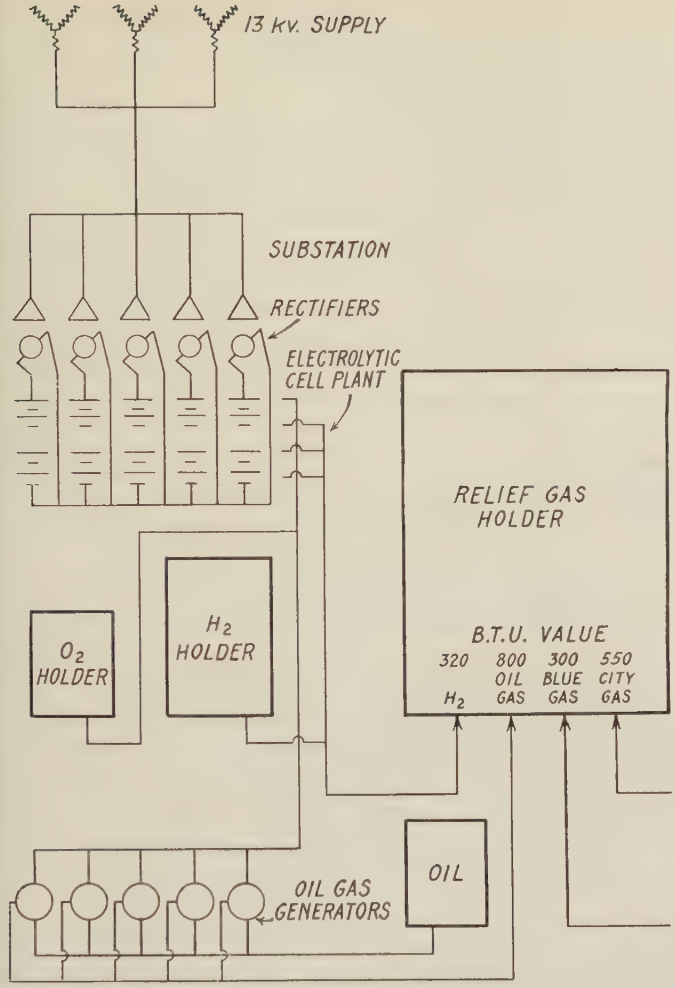

Fig. 4. Schematic diagram of a plant designed to absorb surplus electric energy in the production of gas

It is a well-known fact that when hydrogen costs 40c. and nitrogen 20c. per M. cu. ft., they aggregate 60 per cent of the cost of ammonia when produced at $70 per ton. It is reasonable to assume, therefore, that ammonia could be produced for $50 per ton when manufactured from constituents made from surplus power.

It is known also that 250 cu. ft. of oxygen and 5 gal. of oil of 160,000 B. t. u. per gal. will produce 1,000 cu. ft. of 800 B. t. u. gas and this can be diluted by adding hydrogen or blue gas (uncarbureted water gas). With oil at 4c. per gal., 500 cu. ft. of oil gas and 500 cu. ft. of hydrogen will produce 1,000 cu. ft. of 560-B. t. u. gas at less than 28c. per M. cu. ft. in the holder. Natural gas of 1,100 B. t. u. must be sold at 40c. per M. cu. ft. at the end of the pipe line to compete with this cost.

Oxygen always can be used with coke and water to produce a metallurgical reducing-gas mixture, or it can be used for air enrichment in the blast or open-hearth furnaces, when it can be had cheaply enough. Hydrogen is a fuel gas and also a reducing gas and can also be used in metallurgy when its cost is low enough. When the availability of these gases in large quantity is assured and their cost becomes lower than 35c. per M. cu. ft., they will find a market by reason of the economies their use will produce. This market will enlarge as the price of the gas lowers. If the surplus energy costs shown in Table II are put into effect and no better apparatus than that now available is used, oxygen and hydrogen can be sold profitably at 25c. per M. cu. ft. in 1932 and at 20c. per M. cu. ft. or less in 1940.

All estimates of cost have been based upon the use of new equipment for converting a-c. to d-c. energy. The cost of complete plants to furnish oxygen and hydrogen at uniform hourly rates from surplus power are estimated as shown in Table III.

TABLE III—ESTIMATED COSTS OF COMPLETE PLANTS FOR FURNISHING OXYGEN AND HYDROGEN BY THE USE OF SURPLUS POWER

Input capacity of plant in kw.	Load factor	Cost per kw.
10,000	0.90	$50.00
20,000	0.85	47.50
30,000	0.80	45.00
50,000	0.75	37.50
100,000	0.70	35.00

Substitution of mercury arc rectifiers for motor-generators would lower the cost and there always is the hope that some cheap and effective form of commutating device or electrolytic rectifier may be invented that would deliver pulsating direct current. If apparatus of this type could be obtained at about $5 per kw., oxygen and hydrogen each could be produced for about 10c. per M. cu. ft.

What Surplus Power Now Available Will Do

It may be appropriate at this point to give an idea of what all the surplus energy alleged to be available would do in terms of products:

1. Each a-c. kw-hr. will produce about 9 cu. ft. of gas, of which 6 is hydrogen and 3 oxygen.
2. The 3 cu. ft. of oxygen with coal and water, in the Bosch process, will produce 12 cu. ft. of hydrogen.
3. One cu. ft. of hydrogen with air and heat will deliver two cu. ft. of nitrogen.
4. The 18,000,000,000 kw-hr. estimated as available in 1930 therefore would produce 108,000,000 M. cu. ft. of hydrogen and 54,000,000 M. cu. ft. of oxygen.

The oxygen could be sold at cost. The hydrogen would permit the manufacture of about 1,200,000 tons of synthetic ammonia containing nearly 1,000,000 tons of fixed nitrogen. If instead the gases were used with oil to make 555-B. t. u. city gas, there would be required about 1,062,500,000 gal. of oil and the hydrogen, and 108,000,000 M. cu. ft. of blue gas. The total annual output of city gas would be 432,000,000 M. cu. ft.

Excepting only the use of the gases in metallurgy, the manufacture of fixed nitrogen and fuel gas are the two least remunerative uses for the gases. They have been mentioned because the market for both is large and demonstrates that there need be no delay in putting off-peak capacity to work.

Consider, as a further example of what could be accomplished, that a company were to construct a plant for manufacturing gas by the use of surplus power as outlined in this article, and at the same time build an electric plant especially adapted for supplying such power in addition to its regular load. Assume, for the sake of example, that the output of the electric plant i s rated at 200,000 kw., allowing 10 per cent spare capacity to meet the necessity for continuous service. Such a plant could be built for 80 per cent capacity-use and the energy taken by the electric system as base-load power would be restricted to 60 per cent load factor as being sufficient to best meet the requirements of that system. The cost of such a plant would be $100 per kw., or a total cost of $20,000,000 for the 200,000-kw. capacity. This low plant cost would be due to the simplicity of design possible with high-load-factor apparatus. Fixed charges on such a plant would be 12 per cent, thus providing for a 20-year replacement period.

At an annual load factor of 60 per cent, which is assumed for the base load, the energy output for the electric system would be 1,051,200,000 kw-hr. At this load factor the thermal rate would be about 12,500 B. t. u. per kw-hr., which can be taken as equivalent to

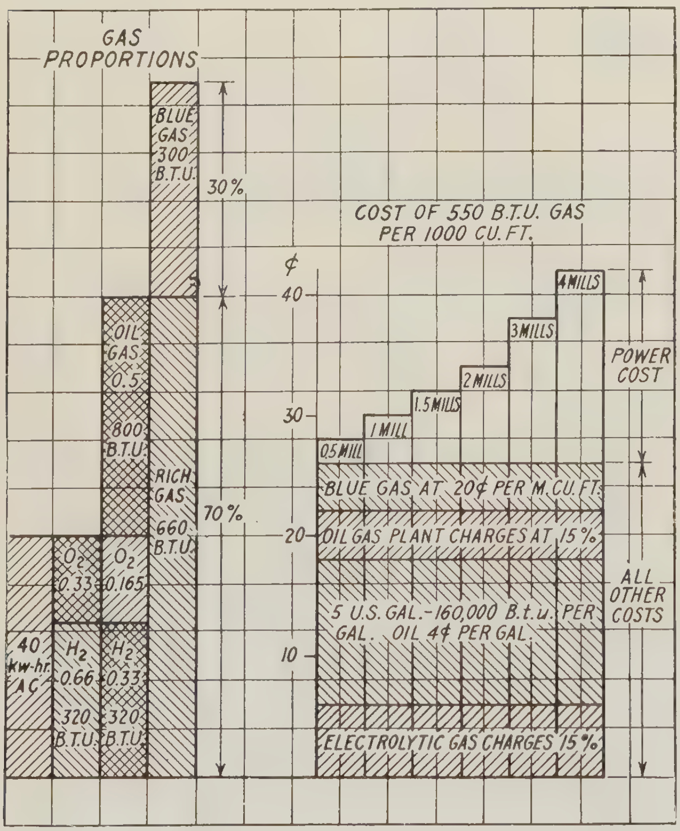

Fig. 5. Chemical composition and costs of gas produced from surplus electric energy. It may be noted that with each successive 5 per cent increment in surplus power used, the cost per kw-hr. increases from 0.5 mill to 4 mills

TABLE IV—GAS PLANT COSTS

Electrolytic Plant	
60,000-kw. converting plant @ $20	$1,200,000
55,000-kw. cell plant @ $20	1,100,000
Gas holders, 3,000,000 cu. ft.	400,000
Total	2,700,000
Fixed charges at 15 per cent	405,000
Products	
Oxygen	1,051,200 M. cu. ft.
Hydrogen	2,102,400 M. cu. ft.
Total	3,153,600 M. cu. ft.
Operation	
350,400,000 kw-hr. @ 1.76	616,704
Operation and maintenance	50,000
Production cost	666,704
Fixed charges	405,000
Total cost for 3,153,600 M. cu. ft.	1,071,704
Cost of oxygen and hydrogen per cu. ft. .34c	
Gas Plant	
Gas plant including holders	3,000,000
Fixed charges at 15 per cent	450,000
Operating Costs	
1,051,200 M. cu. ft. oxygen	357,235
21,024,000 gal. oil at 4c	840,960
Operation and maintenance	40,000
Cost of 4,204,800 M. cu. ft. 800 B. t. u. gas	$1,238,195
Cost per M. cu. ft. 29.4c.	
Add 2,102,400 M. cu. ft. hydrogen	714,469
Cost of 6,307 M. cu. ft. 660-B. t. u. gas	1,952,664
Cost per M. cu. ft. 30.9c.	

one pound of coal. Coal rate is assumed to be 80 per cent of the production cost, which is about 95 per cent of the total cost. Taking coal at $4 per ton the energy cost would be 2.64 mills per kw-hr. The price which ought to be obtained would therefore be about 5 mills per kw-hr. The plant, however, would be loaded to 80 per cent load factor, as the gas plant would be able to use the surplus power in gas manufacture. Based on this load factor the annual output would be 1,401,600,000 kw-hr., and the surplus power output 350,400,000 kw-hr.

The thermal rate based on 80 per cent capacity-use would be 11,500 B. t. u. per kw-hr. This low thermal rate would be obtained by the use of high pressure, high temperature, steam extraction, and reheating. On the basis used for the 60 per cent capacity, the cost of this energy would be 2.42 mills per kw-hr. It is estimated that 75 per cent of this output would be sold at 2.64 mills, leaving the net cost of the surplus as 1.76 mills per kw-hr.

To raise the load factor of the electric system from 60 per cent to 80 per cent, would require a gas plant capable of absorbing about 60,000 kw. Fig. 4 shows a schematic diagram of such a plant. Cost estimates for this plant and its operation are shown in Table IV.

In Fig. 6 is indicated the cost of 800-B. t. u. oil gas when oxygen and oil are used, and the cost of 660-B. t. u. mixed gas when the hydrogen also is used. The costs are related to the cost of the surplus energy.

The feasibility of utilizing surplus power by the method proposed seems to be well established by the examples given. From the standpoint of the power companies, adoption of such a plan would be quite advantageous and it is obvious that the general public would benefit as well through the lessening of manufacturing costs of numerous commodities. It is hoped that this article will revive discussion on this all-important subject, and that it presages the day when some intelligent use will be made of surplus power.

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Cooperative Work on Joint Pole Use

Since both telephone and electric service customers must be reached by the two utilities it is obvious that the joint use of poles would have many advantages to the utilities, the customers, and the community. Important operating problems resulting from such close proximity are receiving joint study; new problems constantly arise with developments in practise. The present status of cooperative study of joint use is outlined here.

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PRINCIPLES and practises for the use of wood poles jointly by electric supply companies and communication companies as recommended by the Joint General Committee of the National Electric Light Association and the Bell Telephone System under date of February 15, 1926 contemplated that each party to such joint use should:

1. Be the judge of the quality and requirements of its own service, including the character and design of its own facilities, both now and in the future.
2. Determine the character of its own circuits and structures to be placed or continued in joint use; and determine the character of the circuits and structures of others with which it would enter into or continue in joint use.
3. Cooperate with the other party so that in carrying out the foregoing duties proper consideration will be given to the mutual problems which may arise, so that the parties can jointly determine the best engineering solution in situations where the facilities of both are involved.

From the foregoing it may be observed that while each party retains full responsibility for its own problems, emphasis is placed upon the mutual advantages accruing from conscientious effort to find the best over-all engineering solution in each particular situation. These principles are among the important recommendations during a decade of cooperative studies, and they form the basis upon which practically all cooperative work is being carried forward.

It is the purpose of the following paragraphs to describe briefly what has been done by the joint subcommittee on development and research and what is being done in connection with the engineering and economic problems encountered in joint use.

Construction Practises

From the inception of the joint use of structures, joint-use construction practises have undergone almost constant change and improvement and continued development is to be expected for the future. However, many of the fundamental requirements for securing satisfactory conditions on jointly used poles were recognized at an early date and form the basis for present day practise.

In so far as practicable, power wires, because of their relatively greater mechanical strength, have been assigned to the upper positions on jointly used poles. Also, with power wires in the upper position, telephone linemen are not required to climb through power circuits, with the exact nature and characteristics of which they are not always familiar.

Good practise dictates sufficient clearance between levels of power and telephone wires to allow for safe working. Where wires to street lights and underground connections to aerial plant require vertical runs on jointly used poles, their location, insulation, and mechanical protection have received careful study, looking toward the elimination of hazards to workmen. Sufficient clearances between vertically run circuits of one type and the equipment of another utility on the same pole have been found to be most important from the standpoint of avoiding service interruption to both power and telephone systems. In this connection it is well to note that any situation where insufficient clearance between power and telephone facilities is provided may result in trouble for one or both.

Present day construction standards therefore emphasize the necessity of maintaining proper clearances as well as strength of construction; and experience shows that where these standards have been practised, trouble from these sources has been kept within a reasonable limit. The joint general committee is giving

From "Status of Cooperative Work on Joint Use of Poles," (**No. 31-24**) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931, as Part IV of a symposium on coordination of power and telephone plant.

careful consideration to the matter of construction standards on jointly used poles. Pending the development of complete specifications covering recommended practises under various conditions, the National Electrical Safety Code is recommended as a guide to practise.

Protective Devices

Both telephone and electric supply circuits are equipped with protective devices fundamentally the same in pinciple and falling within two general classifications:

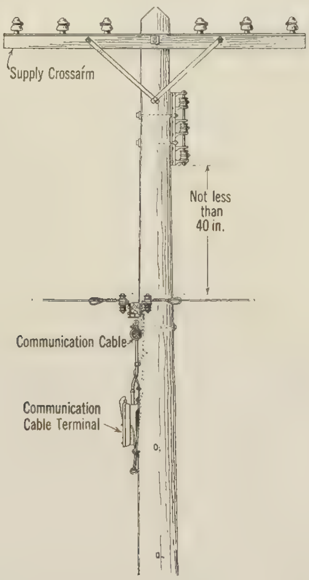

Fig. 1. An example of good practise in joint pole use showing one method of accomplishing satisfactory conditions

1. Those which provide protection from abnormal voltages consisting of protector blocks in the telephone plant and lightning arresters in the electric supply system.
2. Those which provide protection from abnormal currents consisting of heat coils and fuses in the telephone plant and fuses and circuit breakers in the electric supply systems.

These protective devices are of secondary defense against abnormal conditions which it is impracticable to avoid either by design or through adherence to construction standards.

In spite of all practicable precautions with regard to clearances, strength of construction, and insulation, accidental breaks occur both in power and in telephone wires; therefore, and also because of the limitations of protective devices, joint use with certain types of circuits is questionable. Differences of opinion exist between engineers as to the degree of hazard involved in joint use between telephone plant and power circuits of various types, voltages, and connected capacity. This problem has increased in importance as the use of higher distribution voltages and greater generating capacities have been adopted. The joint subcommittee on development and research now is studying several typical rural and suburban areas to determine the over-all advantages and disadvantages of the use of higher distribution voltages and of joint use with these voltages under present conditions.

In connection with these problems the joint committee carried on experimental work to determine the characteristics of various types of fuses. Tests made in a laboratory where 20,000 kv-a. of generating capacity was available showed the range of dependability that could be placed upon the various fuses for interrupting voltages ranging from 2.3 to 13.2 kv. Another phase of experimental work covered breakdowns with direct current and with 60-cycle alternating current, and a complete cathode ray oscillographic study of the behavior of carbon-block protectors and neon and vacuum tubes under steep wave fronts. These tests showed that the carbon-block protector has a breakdown point with all types of applied wave fronts that is sufficiently fast and low to protect the insulation now used in the communication plant. The shortcomings of these blocks lie in their tendency to ground the circuit permanently when forced to carry current for any appreciable length of time. Tests with steep wave fronts were carried to a rate of rise of 36.5 kv. per microsecond.

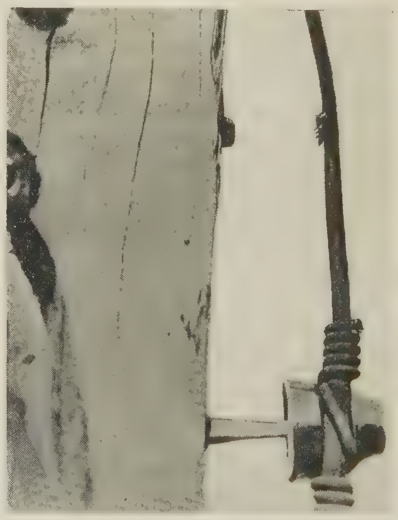

Fig. 2. An example of improper construction. Wire was pulled against through-bolt resulting in an insulation failure which interrupted both services. Wire removed to permit photographing

Mutual Responsibility for Protection

The problem of adequate protection of the telephone plant in joint use obviously cannot be solved by the development of telephone protective devices alone; protective devices in the power system are of equal

importance. One problem in present development and research work is the fixing of the part that the protective devices on each system must play in abnormal conditions; the burden of weaknesses in the protective equipment of one system must not be thrown upon the protective equipment of the other. Therefore, the next step in this investigation is a determination of the over-all characteristics of power circuit and telephone circuit protection under typical conditions of contact between the two.

One of the important functions of the power-system protective devices is that of clearing power-system faults in a reasonable time interval. Obviously, telephone protective equipment cannot be expected to prevent damage to telephone plant in case of contact between the wire circuits of the two utilities when power-system protective devices fail to operate and the physical contact of the circuits is maintained over an indefinite period of time.

All of these problems are being approached upon the basis of determining the best over-all engineering solution to the end that both systems may provide their services in the most convenient and economical manner.

The various operating problems which have arisen almost since the birth of the power and telephone industries, and the investigations conducted by the joint subcommittee on development and research, indicate the importance of giving careful consideration to the inductive coordination features of joint use and of including this factor in studies of the relative advantages and disadvantages of joint use as compared with separate lines. This factor, of course, should be considered from both its technical and economic aspects.

In the inductive coordination of the two distributing systems much can be accomplished by cooperative advance planning. In urban areas where the telephone circuits are largely in cable, there is about a two-to-one ratio in the inductive effects between a joint line and separate lines across the street. In rural areas where the telephone circuits are largely open wire, the ratio of the inductive effects on joint lines as compared with separate lines across the highway is much greater—other things being equal.

In urban areas the power and telephone companies through cooperative planning frequently can arrange to establish important power feeders and telephone circuits on separate streets, thereby avoiding large inductive effects, and permitting more extensive joint use of branch lines. A careful review of the equipment used on the power and telephone circuits and the introduction of operating practises designed to limit the inductive susceptiveness of the telephone circuits and the inductive influence of power circuits, form an important part of advance planning and cooperation.

In the case of rural lines where the telephone circuits are largely in open wire and the exposures between particular circuits are likely to be long, joint use is not always practicable. In these cases locations for separate lines usually are available. Furthermore, joint use in rural areas is not always economical from a purely construction standpoint. Joint use with telephone toll circuits or power transmission lines has not, in general, been found desirable.

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Reactance Relay Performance Reviewed

Results of a year's experience with reactance-type distance relays in the South is interpreted as demonstrating the correctness of the reactance principle. Difficulties that have arisen as a result of interconnections which operate near the stability limit, and other operating problems, are outlined here with resulting conclusions.

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OPERATING EXPERIENCE has shown the correctness of the major principles of design and application of reactance-type distance relays on the system of the Tennessee Electric Power Company. Several difficulties have been encountered, but these have been given less weight than the prime considerations of carrying high loads safely during emergencies and of clearing the majority of faults selectively during all operating conditions.

On February 9, 1930, the company installed three reactance relays at its Great Falls hydro plant. These relays were of the normal-speed distance type (LB-1) furnished by the American Brown Boveri Company, but built in Switzerland by Brown Boveri, Limited. This is believed to be the first installation of reactance relays in this country. Since that time 24 more of the LB-1 relays and 27 General Electric type GAX relays have been installed, making a total of 54 distance relays of

From "Operating Experiences with Reactance Type Relays" (**No. 30-181**), presented at the A. I. E. E. Southern District meeting, Louisville, Ky., Nov. 19-22, 1930.

the reactance type on that system. In addition, six high-speed distance relays of the Westinghouse impedance type (HZ) are now being installed.

In Figs. 1 and 2 are shown typical wiring diagrams for the two types of reactance relays and how the test facilities preferred by the Tennessee company have been applied. If it is desired to use the auxiliary equipment offered by one manufacturer for securing ground protection as well as phase protection, the test scheme becomes more complicated.

Reasons for the rapid installation of these new types of relays may be of general interest; herewith is given a tabulation of the variation in short-circuit kv-a. on the various high-voltage buses of the system. This variation is caused chiefly by changes in operating conditions with steam and hydro generation at widely separated locations. The tabulation covers the total short-circuit kv-a. on the bus; of course, any one outgoing line has substantially less current.

The location of circuit breakers on the 154-kv. and 110-kv. systems, together with the type of phase protection now in service at each are shown in Fig. 3. Many of the line sections are of No. 2/0 copper or its equivalent. The map, together with the table of short-circuit kv-a., shows why the short circuit at the end of a long section may be even lower than the normal load of the line. Furthermore the opening of a section under fault frequently requires the adjacent sections to carry as much as twice normal load for a minute or more. Over-current relays (and relays having over-current pick-up) have proved inadequate and almost useless under these conditions.

TABLE I—VARIATION IN SHORT-CIRCUIT KV-A. ON TENNESSEE ELECTRIC POWER SYSTEM

	Maximum	Minimum
Arlington	680,000	160,000
Centerville	360,000	170,000
Great Falls	480,000	210,000
Hales Bar	600,000	250,000
Ocoee No. 1	780,000	250,000
Ridgedale	560,000	220,000
West Nashville	390,000	180,000
Wilson Dam	800,000	150,000

The principle of the distance relay finds a ready application in handling this situation. Reactance-type relays were preferred over the impedance type since it is thought that the former give a more accurate measurement of the distance to the fault by being independent of arc resistance.

Certain factors relating to the installation and operation of both types of relays have been demonstrated conclusively and are outlined in the following paragraphs.

High-voltage-potential supply is necessary in practically all cases because incorrect operation is likely to result when running on low-voltage supply. After trying various substitutes, the potential transformer has proved the best, and in the long run the most economical source. Pilot indication is highly desirable on potential supply; neon lamps serve this purpose admirably.

By the use of distance relays each section of line is protected independent of other sections and selectively without cascading relay settings.

The amount and location of generating capacity has no appreciable effect on the time of clearing faults. Loads much beyond the sustained thermal capacity of a transmission line can be carried without tripping, but if the voltage is low enough to indicate a fault in the protected zone, a secondary current of about two amperes or more will operate the relay in a predetermined time. Impedance releases or starting units on reactance relays, however, should be set rather high—say at ten amperes or more.

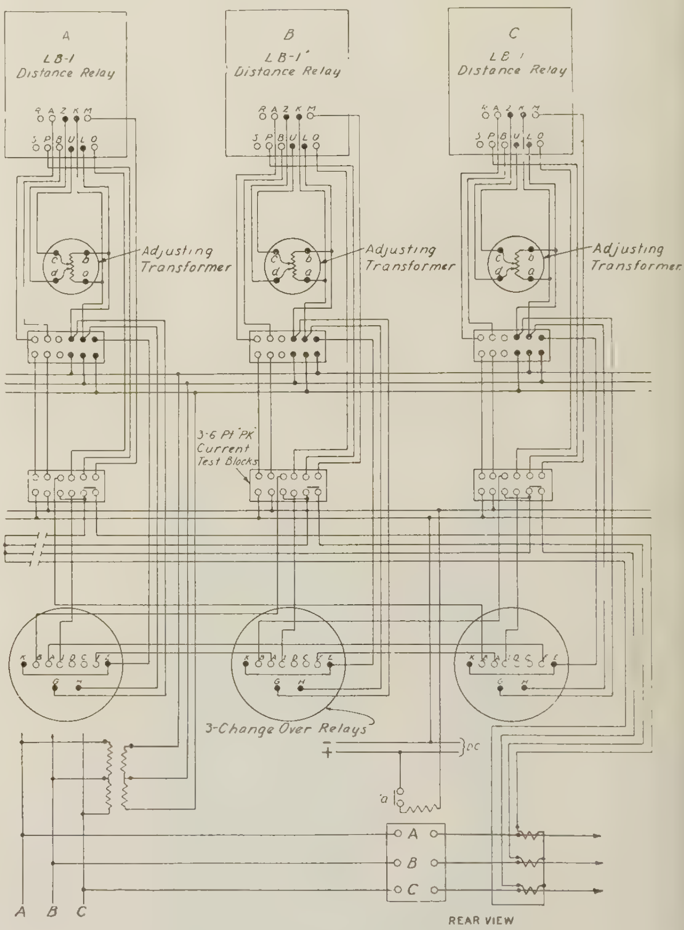


Fig. 1. Wiring diagram for type LB-1 distance relays

Relays of this type can also be used for fast bus protection, but it is not possible to obtain correct directional action in all cases for heavy faults close to the station. It is recommended that the buses of important stations be protected independently so that the distance relays may be used for outgoing protection only.

Both types of reactance relays have been found to operate on arc faults in the same time as on solid short circuits, even up to the longest arcs that could be maintained on the system.

The cost and importance of distance-relay installations justify maintaining complete and accurate operating records, and a careful study of these records after they are obtained. This does not mean, however, that relay settings or schemes should be modified on account of one report of incorrect operation; it is too difficult for the average operator to determine exactly what happens and except in case of careful observation on staged test, too much weight should not be given to any one reported erratic performance.

Quick-trip ammeter installations as used to record neutral-ground current have been very helpful in analyzing relay operations. The absence of a ground-current record indicates a phase-to-phase short circuit which should operate the distance relays. These graphic ammeters frequently show ground current at the same time the distance relays operate, indicating a two-phase-to-ground short circuit, or a phase-relay operation on a single-phase-to-ground fault. Automatic oscillograph installations should also be very valuable in analyzing relay operations especially on occasions when the station operator's time is limited.

In this territory most of the high-voltage phase-relay operations occur in June, July, and August, during the height of the lightning season, thus giving a rather limited time in which to make and note the effect of any changes in relay installations. This means that in order to record the effect of any improvement or revision before the lightning season ends, questionable or incorrect operations must be followed up promptly. The lightning storms are not only concentrated during the summer months, with a peak in July, but these storms also occur most frequently in the afternoon. This extreme concentration of trouble greatly complicates relaying and dispatching problems due to independent troubles occurring close together, or even simultaneously. A second line may relay out before the first line can be closed back in, thus leading to confusion in the operating records as well as to interruptions to customers provided with two or more sources of supply, even though none of the circuits are in trouble permanently.

One type of reactance relay is equipped with a distance indicator which has been very helpful in studying the conditions under which the impedance release operated. It would also be desirable to have more than one target on the step-by-step distance relays so that there would be a record of whether the relay tripped on instantaneous, intermediate, or back-up time. It has been found impracticable to determine this by watching the relay, even on staged tests.

For distance relays, no entirely satisfactory method of low-voltage routine tests has been devised but they have been checked by staged tests during installation and in case of questionable operation, occasionally thereafter.

In addition to the foregoing conclusions regarding distance-relay performance there are certain questions which in the opinion of the writer have not been definitely answered as yet. These together with some of the evidence that may be helpful in reaching conclusions, especially when and if corroborated by further experience, are outlined in the following paragraphs:

Table II is a condensed summary of the operation of distance relays on this system from the dates of their installation up to the present time. Details of these operations are tabulated in the complete paper.

Apparently the operation of all types of these relays is highly satisfactory on radial feeders. The only difficulties arise on trunk lines and on interconnections where wide variations in power factor during load swings seems to be one of the chief difficulties.

The performance of distance relays under out-of-step conditions is still uncertain; this liability, however, is not confined to these relays, as it is definitely known that the old impedance relay will operate quickly on any out-of-step condition if the current peaks exceed

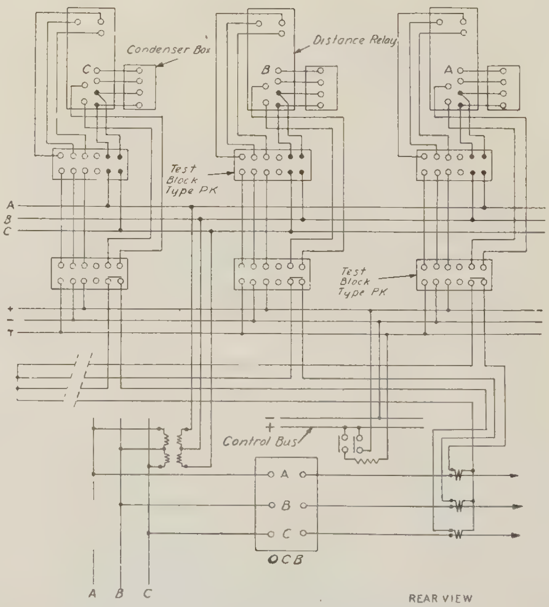


Fig. 2. Wiring diagram for type GAX distance relays

the pick-up value for a short time. Many interconnections are subject to more or less prolonged surging somewhat below the stability limit and relays should hold in all such surges. This is one of the problems on the East Tennessee interconnection.

Unfortunately, however, there is no precedent for saying that a line should or should not relay on out-of-step conditions. As a result of relay subcommittee investigation, it has been suggested though tentatively

that severe out-of-step conditions should cause relay operation, but only at one location which should be at the point of maximum voltage variation.

Operating experiences also show that impedance releases or starting units should have reset values fairly close to the release values, particularly if the starting unit is non-directional. Otherwise a fault may be cleared promptly at some other location, but the resulting surging or readjustment of power flow may be sufficient to hold the relay released and cause incorrect operation.

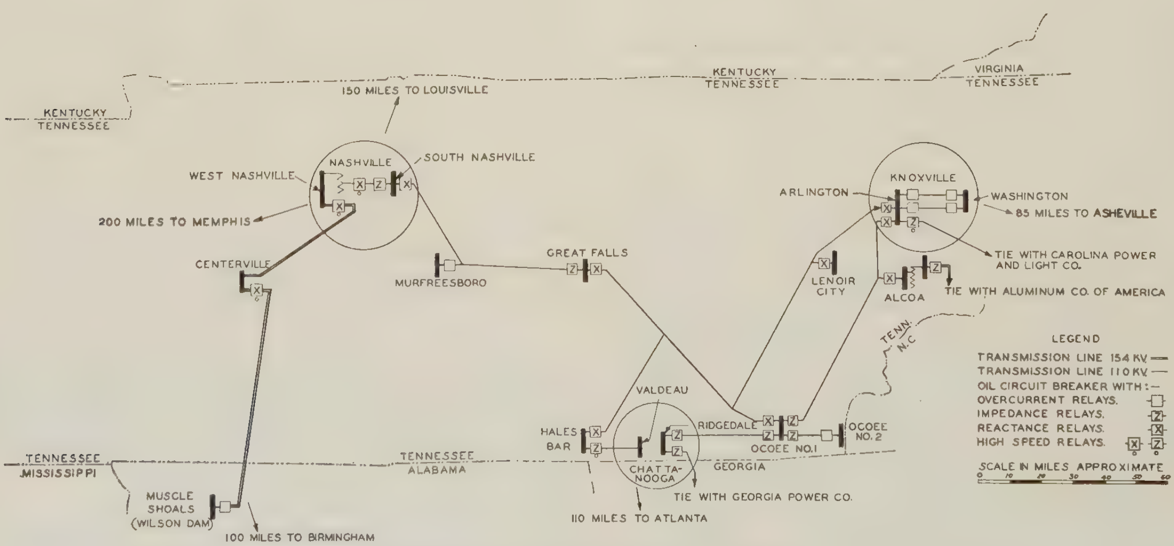
TABLE II—SUMMARY OF REACTANCE-RELAY OPERATIONS

Correct operations	47
Questionable operations	7
Wrong operations	0
Inadequate potential supply	18
Total	72
Analysis:	
Correct operations	
Line relayed at one end only	3
Same line relayed simultaneously at other points	28
Line relayed while being supplied from one end only	5
Back-up protection	3
Low-voltage bus failure	1
Bad synchronizing	5
Bus protection	2
Total	47
Questionable operations	
Out-of-step conditions	7
Total	7
Inadequate potential supply	
Cross-phased	3
44-kv. trouble	5
Bushing potential devices	5
110-volt secondary trouble	5
Total	18

In this connection it would be advantageous for the starting units to be made more readily adjustable. At present they are designed and factory-adjusted so as to give back-up protection to only two or three average sections of line, while the distance measuring element is flexible and can be adjusted for almost any combination of sections. The time setting on intermediate and back-up operation of step-by-step distance relays should be rather long—probably 60 cycles or more for the intermediate time if used on heavy interconnections. This is a tentative conclusion from operating experience on the East Tennessee interconnection.

The instantaneous element on a distance relay may operate too quickly if the relay trips under two or three cycles, since incorrect operation may occur due to breaker adjustment. A certain definite time is required for proper directional discrimination, and it does not seem to be wise to try to speed up the initial time too much on certain types of relays.

Distance relays can be used successfully on the same system with other types of relays, but if the ordinary types of relays operate slowly under minimum generating conditions, the distance relays will operate frequently ahead of them. It is entirely feasible however to use separate and independent ground protection with these relays. For ground protection it has always been the practise of this company to use current directional ground relays and no change was made in this practise when distance relays were installed for phase protection; however, both manufacturers have developed schemes of ground protection using distance relays and star potential supply.



PHASE PROTECTION OF 154 AND 110 KV. SYSTEMS

Fig. 3. Schematic diagram depicting distance relay applications on the Tennessee Electric Power Company's system

Electrical Porcelain

Simple comparative tests of American and European samples of standard insulating porcelains reveal strikingly similar characteristics in the finished products in spite of variations in raw materials and manufacturing processes.

By H. M. Kraner

Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

ALTHOUGH the investment in the insulators used on a modern transmission line represents only a very small percentage of the total cost of the line, much depends upon their continuous and satisfactory performance as an electrical insulator and a mechanical support.

While the electrical industry was still young, the ceramic industry was operating on rule-of-thumb methods. As a result, it was difficult for the electrical engineer to know anything more about porcelain than that the product of one manufacturer was satisfactory whereas that of another gave trouble under the various new conditions which were being encountered. Recent advances in silicate chemistry, made possible by the use of the petrographic microscope, and the application of fundamental mechanical tests to these materials, has done much, however, to diminish this handicap. As a result, manufacturing methods have been improved greatly, and porcelains of much better quality and greater uniformity now are being produced.

Nearly all the many kinds of porcelain now used for transmission line service are made essentially of clays, flint (quartz) and feldspar. Obviously porcelains having all kinds of properties might be made by varying the proportions of these constituents, by good and bad methods of mixing and forming, and by firing at various rates and for various lengths of time.

The clays are used for their unique plasticity which makes possible the molding and drying of the pieces. Flint (quartz) is a somewhat inert refractory material which during firing adds viscosity to the mass and also acts as a skeleton for the entire mass at that time. Feldspar is a melting constituent which, when fused, carries the clay and some of the quartz into solution in the resulting glass matrix. Thus the clays are all-important in the forming operation, while the feldspar is particularly important in the firing process.

Unlike many manufactured products in which the final operation before assembly brings the piece to the prescribed dimension, porcelain undergoes the firing process with a 12 per cent shrinkage after the final dimensioning operation. Any irregularity in the manner in which the piece is placed or fired may affect its ultimate dimensional accuracy and hence the firing as well as the composition is extremely important.

European practise is to fire to approximately 1,400 deg. cent. whereas only 1,200 deg. cent. with a longer firing time is customary in America. Analyses show, however, that the chemical composition of these porcelains is very similar.

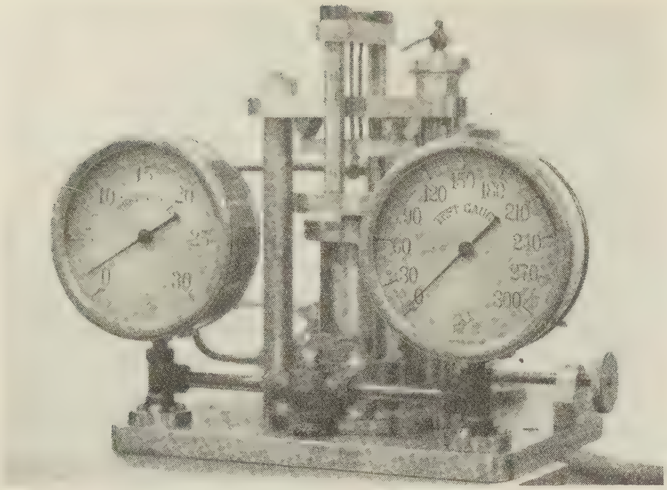
European contemporaries have conducted much more fundamental testing on various ceramic materials than has been done in this country. American tests have been limited to those properties which are directly applicable to, and of value in, the finished products—tensile strength, compressive strength, cross-bending strength, impact and dielectric strength. Of these the cross-bending test seems to be most suitable for fundamental indication of the merit of a porcelain. Small inaccuracies in the test piece do not greatly affect the results obtained, and the variation in diameter does not affect the modulus of rupture of a given material as in the case of tensile testing. It has been found also that this method of testing can be used to good advantage as a control procedure in the factory.

Results of a series of cross-bending tests made on various types of porcelain with the machine shown in the accompanying illustrations are given in Table I. As may be noted, the strain cable on the testing machine applies load to the center of the test bar in such a way that the distribution of stress across the diameter of the bar is uniform. Round test pieces 3/8 in. in diameter and 3 in. long were used.

As Table I shows, the resistance of the material to heat shock also was determined. This was done by heating the small test pieces to the temperatures indicated, and quenching them in water at room temperature. The change in strength after such treatment is an indication of the value of the material's resistance to heat shock regardless of the method of manufacture. It is interesting to note that the modulus of rupture for the various samples of American porcelain tested gave a maximum deviation of only three per cent from the average. These results clearly demonstrate also that the improvement in properties resulting from firing at temperature much higher than encountered in American practise is not so great as might be expected, nor at all commensurate with the higher firing cost involved.

High-strength compositions for somewhat stronger insulators are possible, however. In this connection it must be remembered that the economics of the situation keep the industry within fairly narrow limits. The increase in cost attributable to the use of more expensive materials is relatively slight; the real expense comes in the fuel used to obtain the higher firing temperatures required for such compositions, which at

From "Electrical Porcelain," (**No. 30-163**) presented at the A. I. E. E. Middle Eastern District meeting, Philadelphia, Pa., Oct. 13-15, 1930.



Front view of porcelain tester showing test sample in place and method of obtaining evenly distributed strain

present is about 40 per cent of the total manufacturing cost.

It may be noted from Table I that several materials show greater strength unglazed than glazed. This indicates that these glazes have a coefficient of expansion widely different from that of the body and place the two under differential stress. A properly fitting glaze should increase the mechanical strength of the porcelain by sealing the exposed contacts between the grains of the structure.

TABLE I—MODULUS OF RUPTURE OF CERAMIC MATERIALS, INCLUDING TESTS ON QUENCHED SAMPLES

	Lb. per sq. inch			
		Quenched from		
	Not quenched	200 deg. cent.	300 deg. cent.	400 deg. cent.
Standard American porcelain				
Glazed—regular glaze coating	14,805	12,990	4,394	4,060
" thin glaze coating	13,357	11,350	4,443	3,816
" very thin glaze coating	12,327	11,350	4,804	4,069
Unglazed	12,310	5,472	4,541	4,084
German Porcelain A				
Glazed	15,594	16,225	12,110	3,466
Unglazed	14,047	13,900	4,724	4,843
German Porcelain B				
Glazed	14,004	14,400	3,184	3,305
Unglazed	12,327	11,048	3,952	3,509
German Porcelain C				
Glazed	10,797	5,012	3,730	3,571
Unglazed	12,786	10,465	4,291	3,853
Steatite (plastic process)				
Glazed	20,086	14,550	All shattered	
Unglazed	15,667	7,266	5,720	4,166
Melalith				
Glazed	11,236	All shattered		
Unglazed	14,810	5,204	4,311	3,327
Sillimanit				
Glazed	12,926	13,231	3,510	3,125
Unglazed	11,135	4,480	3,382	3,440
American Chemical Stoneware				
Glazed	8,922	7,670	3,390	2,920
Unglazed	7,980	6,013	3,305	2,655

In some cases the glaze is detrimental to resistance of thermal shock; for upon quenching, it not only weakens, but shatters badly. The question of glaze fit has been studied from various angles and its importance has been demonstrated in many different ways.

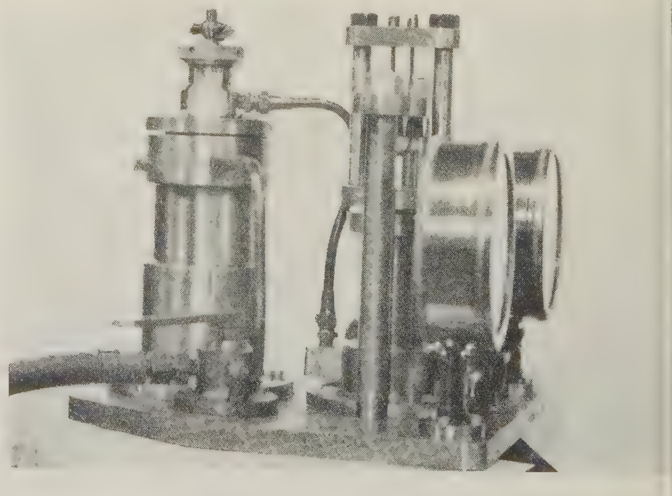
In regard to the uniformity of composition of porcelain now being manufactured, it is sufficient to say that recent chemical analyses reveal only slight differences in these compositions. The best of them is not the highest in silica content, nor the lowest in alkali content (therefore lowest in feldspar); and it has only an average clay content as judged from the alumina present.

The manufacturer of porcelain undoubtedly will find that he can make the greatest strides towards producing a reliable product by keeping his processes as simple as possible and by developing rational methods of control for them. This, unfortunately has not been done extensively, but a striving for uniformity in this manner is undoubtedly of greater benefit to the industry than the use of peculiar processes of unproved or questionable scientific value.

Checking raw materials, fineness of grinding within the plant, consistencies, forming and drying operations and particularly firing processes should be under close control and observation at all times. A full understanding of the effects of varying cooling rates at the various stages of the cooling cycle is also necessary for the most effective operation.

For a long time the x-ray has been looked upon rather hopefully as a possible means of accomplishing routine inspection of porcelain for flaws. But unfortunately the length of time required for an exposure prevents it being used as anything but a laboratory tool.

The assembly of the fired porcelain into pin-type or suspension insulators is as important, or perhaps even more important, than the production of the porcelain



Side view of porcelain tester

itself, for with faulty design or assembly, the best insulating medium may give only inferior mechanical strength and insulating value.

Cement used in the assembly of the insulators must be controlled for uniformity as closely as the clays used in making the porcelain. Temperature variations affect the viscosity and resulting thickness of plastic coatings applied to sand bands and other parts incorporated in the assemblies.

Within the last few years the design of the various parts of these assemblies has been studied systematically from purely theoretical, mechanical, and mathematical standpoints. Photoelastic studies by which accurate determination of stress concentrations in these assemblies have been made have assisted materially in determining the best types of design. The use of other methods of stress studies in three-dimensional models has now been developed. These studies have paved the way for a distinct advance in insulator design, the benefits of which have already been made apparent.

◆ ◆ ◆

Hydrogen Cooling for Turbine-Generators

With the development of efficient sealing glands and reliable control apparatus the already proved advantages of hydrogen gas as a cooling medium for rotating electrical machinery appear to be readily available for large generators. Actual operating experiences with a 7,500-kv-a. unit are outlined here.

By M. D. Ross
Associate A. I. E. E.
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

LARGE TURBINE-GENERATORS of today are appreciably smaller, more reliable, and more efficient than the corresponding machine of even five years ago. These improvements are traceable largely to such factors as better methods of ventilation, stronger rotor steels, lower loss in armature laminations, and improved methods of insulating rotor windings. However, in recent designs for the larger machines using present materials, methods of construction, and accepted performance characteristics, there are indications of a close approach to the limits of possible ratings. Therefore, it is believed that any marked further advancement in performance or maximum size probably will result only from radical changes in fundamental design.

Consequently, a great deal of research has been carried out recently in connection with the cooling of rotating machinery by means of gases other than air. A survey of available gases shows that because of its low density (about 7 per cent that of air) and high heat-transfer characteristics with forced convention, hydrogen is the gas most suitable for this purpose. Furthermore, since windage losses vary approximately in proportion to the density of the cooling medium, such losses through the use of hydrogen can be reduced to a negligible figure. Some of the advantages of hydrogen as a cooling medium for rotating electrical machinery are summarized briefly:

1. Windage losses, which may be as much as 40 or 45 per cent of the total losses, are reduced to about 10 per cent of their value in air.
2. For a given amount of active material the rating of a generator with hydrogen cooling would be about 25 per cent greater.
3. In an atmosphere of hydrogen corona has little, if any, effect on insulation. Insulation operating in hydrogen therefore should have a much longer life than in air.
4. Because of the absence of oxygen, fires in the generator cannot occur.
5. Smaller gas coolers and less cooling water are required than with air cooling.

Shaft Seals for Turbine Generators

One of the most important developments in connection with hydrogen cooling for turbine-generators has been the design of sealing glands to prevent gas leakage around the shafts where it emerges from the gas-tight enclosure. Experimental work started in 1925 and which covered various methods revealed that a liquid seal employing oil as the sealing medium was best adapted for use with the relatively high shaft speeds involved. Data showed also that a suitable supply of oil under pressure could be obtained from the turbine lubrication system.

An experimental sealing gland was built in 1926 to determine the performance that could be expected in seals for large generators; details of this gland are shown in section, in Fig. 1. Oil under pressure is fed into a groove in the center of the seal and flows both ways over the shaft; the oil film thus formed between the shaft and the seal casting is sufficient to stop the flow of gas at that point provided the oil pressure is higher than the pressure of the gas in the machine. The flow of oil is throttled to a minimum by three

From "The Application of Hydrogen Cooling to Turbine-Generators," (**No. 30-177**) presented at the A. I. E. E. Southern District meeting, Louisville, Ky., Nov. 19-22, 1930.

small brass rings fitted closely into grooves in the seal casting and held lightly against the shaft by coil springs.

Tests made on this gland showed that the loss of hydrogen through the seal was very small and that no special detraining tanks were required to separate the hydrogen from the oil before returning the oil to the main system. It was found however that a certain amount of air was being carried into the gas enclosure by the gland oil. Therefore from time to time a quantity of hydrogen gas would have to be added to the mixture to maintain a suitable purity within the machine. Tests showed that for the largest machines this quantity should not exceed 200 cu. ft. per day.

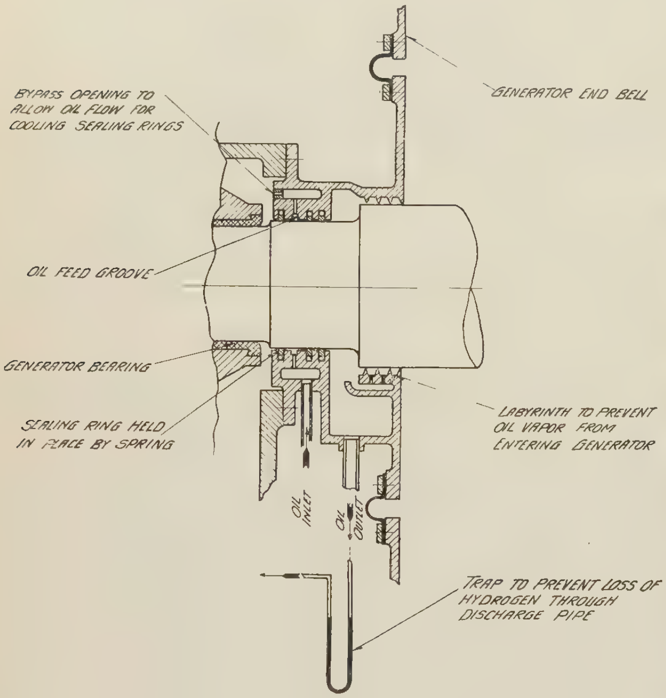


Fig. 1. Sectional elevation revealing details of hydrogen sealing gland

Experimental Turbine Generators Built

In 1928 a 7,500-kv-a., 3,600-rev. per min. generator designed for hydrogen cooling and incorporating the sealing gland just described was built and tested. The frame was constructed along standard lines with certain modifications to make it gas tight. Tests on this machine indicated that in order to obtain minimum gas leakage, frame structures for hydrogen cooling would have to be quite different from the air-cooled designs.

Accordingly early in 1930 a second machine of the same capacity and speed was built and put on test (see Fig. 2). The generator frame was fabricated from steel plate with a minimum length of bolted joints. Active parts of the generator were the same as the standard air-cooled machine parts, and no particular effort was made to design the machine to obtain maximum results with hydrogen cooling. Two sealing glands of the type described were provided, rigidly attached to the bearings, and connected to the end-bells by flexible diaphragms.

Two Griscom-Russell finned-tube gas coolers were built into the generator frame *above* the armature core. To simplify construction and to make the cooler sections more accessible for cleaning straight-tube coolers were adopted and since experience with coolers on a large number of machines never had indicated trouble from leakage or fractured tubes no operating hazards were considered involved in placement of the coolers above the generators.

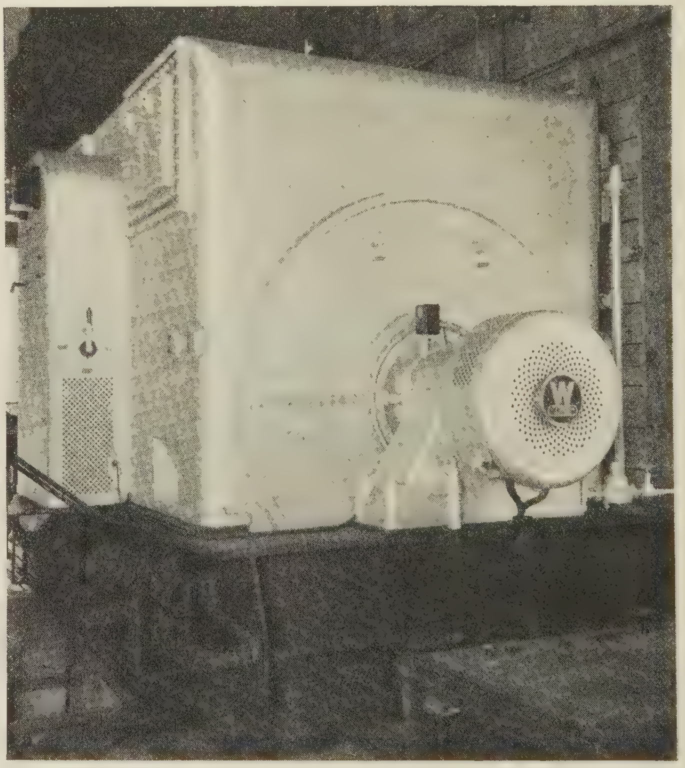


Fig. 2. A 7,500-kv-a. generator with frame and housing designed for hydrogen cooling. Fin-type coolers may be noted above the rotor; control cabinet at the left

Armature leads were brought out through six gas-tight condensers bushings in a flange on the bottom of the generator. Through holes drilled in the shaft field leads were carried to a point outside the bearing where they were connected to the collector rings. Insulating stuffing nuts were provided to keep the gas from leaking around the field leads.

A special system for controlling the gas in the machine was developed, as simple and sturdy in design as possible so that its operation would be readily understood

by the average station attendant. In Fig. 2 the control panel is shown bolted to the side of the generator. Principal functions of this apparatus include:

1. Maintenance of gas pressure in the machine at somewhat above atmospheric, to avoid leakage of air into the machine.

2. Warning to the operator when the purity of the gas is too low, so that more hydrogen may be added to bring it up to the proper value.

Electrically-operated intake and relief valves controlled by pressure-operated switches maintained the pressure in the machine at the proper level. A small motor-driven fan running at constant speed drew a small quantity of gas from the generator and before returning it to the machine forced it through an orifice. The pressure difference between the two sides of the orifice is proportional to the density of the gas passing through it. This difference in pressure was registered on a gage

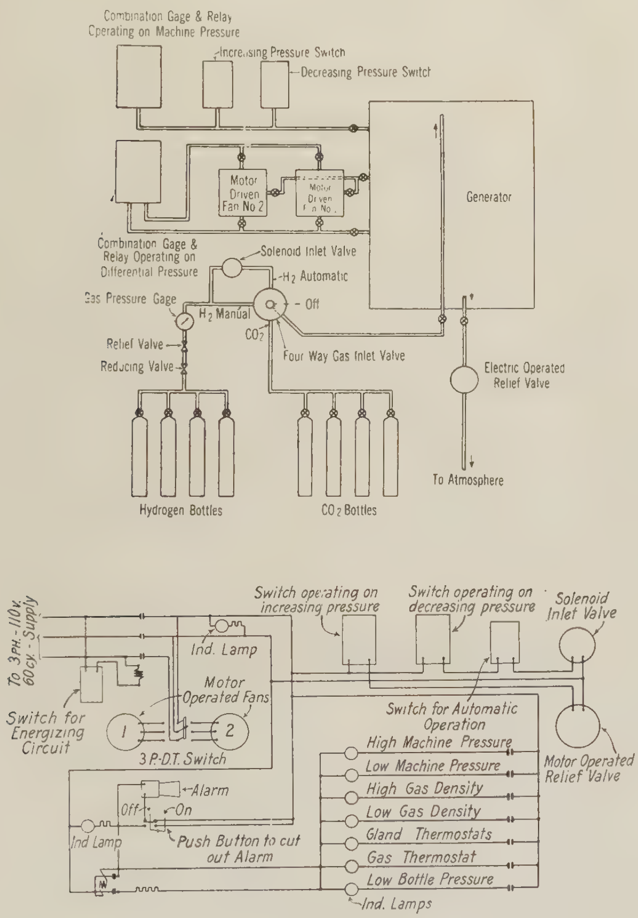


Fig. 3. Piping and wiring diagrams showing hydrogen handling and control methods

mounted on the front of the panel, so that the operator could readily determine the purity of the gas in the machine. Under normal operating conditions, the purity of hydrogen in the machine was maintained at a value greater than 95 per cent which, considering that mixtures of air and hydrogen containing more than 70 per cent hydrogen are non-explosive, allowed a wide factor of safety.

Piping required for the gas system is shown schematically in Fig. 3. Fig. 4 shows the wiring diagram for the electrical apparatus used to operate the gas control system. As may be noted, alarms are provided to warn the operator in case of any troubles in the gas system. A supply of carbon dioxide gas is provided with suitable control valves, to take care of removing the air when filling the generator with hydrogen or to remove the hydrogen when scavenging the machine so that explosive mixtures will not be obtained.

Experimental Operating Data

Up to the time of writing this paper the generator now under test has been operating satisfactorily for seven months. No troubles were encountered with the control and sealing gland features and the glands themselves showed no evidence of wear when inspected after intermittent running with no special attention. Whenever the generator was shut down with hydrogen in it the oil pump was kept in operation to maintain the seal at the shafts. Without oil pressure there was some leakage of gas through the sealing glands, but the infiltration of air probably would be very slow.

Comparative temperature rises of the stator and rotor of this generator with air and with hydrogen cooling are given in Fig. 4. With hydrogen cooling, the machine could be rated at 9,375 kv-a., 0.8 power factor. The windage loss with hydrogen was 7 kw. as against 73 kw. with air. This represents an improvement in

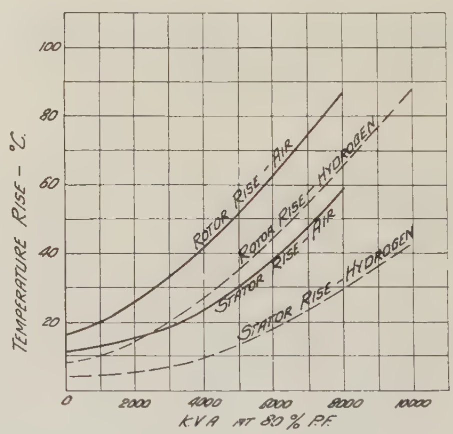


Fig. 4. Operating characteristics of a 7,500-kv-a. machine operating in air and in hydrogen

efficiency of 1.1 per cent at a 6,000-kw., 0.8-power-factor load. The cooling water required for 9,375 kv-a., 0.8 power factor with hydrogen cooling was approximately 40 gal per min., as compared to 80 gal. per min. with air cooling and only a 7,500-kv-a., 0.8-power-factor load.

Desirability of Adopting Hydrogen Cooling

The first question usually raised in connection with hydrogen cooling is: what will happen in case of an explosion? With the worst mixture of air and hydrogen, the explosion pressure will be from 50 to 75 lb. per sq. in., depending upon the size and shape of the gas chambers in the generator. If the frame is provided with a number of diaphrams which will blow out at relatively low pressures, the pressures developed will be lower than the foregoing values. Operating hazards with a hydrogen-cooled generator on a control system such as that just described probably is no greater than those involved in operating other types of station control equipment; therefore it is questionable as to whether frame structures for hydrogen-cooled generators need be made explosion-proof. No attempt was made to design the two 7,500-kv-a. generators described in this article to withstand explosion pressures; however, if an explosion-proof frame be considered necessary it could be built with some increase in cost over that of the lighter frame designed on the basis of gas tightness only.

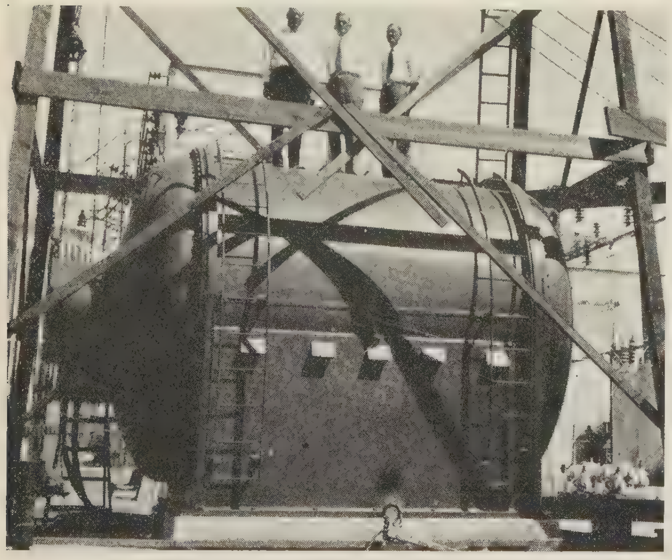


Fig. 5. A 15,000-kv-a., 750-rev. per min., 50-cycle, hydrogen-cooled, synchronous condenser being installed by the Southern California Edison Company, Ltd.

Several hydrogen-cooled synchronous condensers are now in service and as indicated by the number of this type of machine now on order are growing in popularity. As the synchronous condenser does not have to be mechanically coupled with any other apparatus, it can be enclosed readily in a gas-tight casing with provision for cooling the hydrogen gas and recirculating it. The problem so far as hydrogen-cooled turbine-generators are concerned is somewhat different as in order to couple it to the turbine the generator shaft must be brought out through the gas-tight enclosure. It is desirable also to bring the collector-end shaft outside the enclosure to permit work on the brushes while the machine is in operation. This is an important feature in turbine-generators which are sometimes run six months or more at a time without shut-down. However, with the development of sealing glands and control apparatus to the point where their operation can be relied upon in continuous service, there is no apparent reason why hydrogen cooling should not be adopted for large turbine-generators.

Preliminary studies indicate that hydrogen cooling would be desirable in ratings of from 30,000 kw. up. In comparison with the cost of the generator, additional cost of gas-tight enclosures and the control equipment would be relatively small, and the saving in losses would justify the slight additional complication due to this method of cooling. The cost of hydrogen gas should not exceed two dollars per day for the largest generators—a negligible figure when compared to savings in generator losses. As the turbine floor attendant can take care of the gas control equipment the labor cost for operating the generator would be no greater than for an air-cooled generator and while the hydrogen-cooled design would be somewhat harder to take apart than an air-cooled design, the absence of dirt and corona effects in the machine would probably more than balance that point in estimating the cost of maintenance. With built-in gas coolers, as in the hydrogen-cooled machine, considerable space under the generator would be available for removal of condenser tubes and for auxiliary apparatus which is not available with air coolers located below the generator.

The following example indicates the savings in operating expenses with hydrogen cooling, and the possible capitalization of these savings:

Assume:

1. A generator of 100,000-kw. rating, at 1,800 rev. per min.
2. Reduction in windage losses with hydrogen cooling to be 600 kw.
3. Operating time per year to be 7,000 hr.
4. Value of power at the bus to be 0.4 cent per kw-hr.

Savings can be evaluated as follows:

Value of power at bus (4,200,000 kw-hr.)	$ 16,800
Less cost of gas at $2 per day and cost of hydrogen and carbon dioxide for three fillings after shut-down	1,100
Net saving per year with hydrogen cooling	$ 15,700
Capitalization of savings at 15 per cent	$105,000

While the first machines built will cost probably somewhat more than the equivalent air-cooled machines, it is hoped that eventually the hydrogen-cooled design will be produced for the same cost per kv-a. as the air-cooled design.

President Lee *answers* Governor Pinchot

As a matter of record the full text of a telegram received at Institute headquarters from Governor Gifford Pinchot of Pennsylvania and the full text of President Lee's reply thereto are set forth herewith.

Governor Pinchot's Telegram

January 28, 1931

My dear Mr. Lee:

The Annual Meeting of the American Institute of Electrical Engineers now in session is the occasion for my bringing to your attention a matter of grave social import which seemingly calls for action by an association of engineers specializing in the electrical field. The American system of regulation of the electrical industry by state commissions is threatened. The failure of our commissions adequately to control electric service furnished to the homes and stores, and farms, of the country, has occasioned widespread public discontent.

While these consumer groups use not more than one-quarter of the electricity generated they supply approximately sixty per cent of the industry's revenues—and that the most stable portion, as experience in the present depression demonstrates.

One of the principal difficulties in regulating domestic, commercial, and rural electric service is the entire absence of any literature on distribution engineering—a phase of expense peculiar to the service to small consumers and alleged to account for our high domestic, commercial, and rural rates.

Our public service commissions have at their disposal a wealth of information about the generation of electricity and about its transmission. But about distribution, which covers the ultimate disposition of transmitted current to our homes, stores, and farms, there is not a word. The subject has never been discussed before any engineering society—local or national. The secretary of your Institute is authority for the statement that the proceedings of your own organization do not mention distribution.*

Over twenty billion kilowatt hours of electricity were sold to these three classes of small consumers—homes, stores, and farms —in 1929 at an average rate of over 6½ cents per kw-hr. Subtracting an ample allowance for the generation and transmission of the current it will be seen that revenues from this distribution amounts to upwards of $900,000,000 annually out of the industry's total receipts of about $2,000,000,000.

It is most unfortunate that this vast field of engineering and social outlay remains uncovered by an appropriate literature. It would be of material assistance to those of us who are charged by the people with the responsibility for effective and confidence inspiring regulation to have the cooperation of your organization in providing us with the results of technical discussion of distribution engineering, including distribution costs. With the importance and social significance of the matter brought to your attention, I shall hope to see a start made on a literature of distribution comparable to those of generation and transmission.

Yours very sincerely

Signed Gifford Pinchot

*Editor's Note: Apparently this statement represents a misinterpretation of a reply by the editor of Electrical Engineering to an inquiry from Mr. Morris L. Cooke of Philadelphia, relating *exclusively* to distribution *costs*. It is a matter of record that more than a dozen papers dealing with various phases of distribution engineering have been published by the Institute within the past two years.

President Lee's Letter

February 7, 1931

My dear Governor:

Replying to your night letter of the 28th ultimo and with further reference to my acknowledgment of February 3: Your message claims the entire absence of any literature on distribution engineering and also states that our public service commissions have at their disposal a wealth of information about the generation and transmission of electricity, but about distribution, not a word.

For years past, the American Institute of Electrical Engineers has had an active committee on power transmission and distribution, this being one of the standing technical committees of our organization. A large number of papers and discussions upon distribution engineering has been presented at meetings of the Institute and these have been published in our monthly Journal and quarterly Transactions, and are available to the public.

In Pennsylvania, as in most other States, every electric public utility company is required to report in considerable detail on its plant and operations, including for its distribution system its costs under the following headings:

Land	Overhead services
Leaseholds	Underground conduits
Rights-of-way	Underground conductors
Distribution system structures	Underground transformers
Poles and fixtures	Underground transformer installations
Overhead conductors	Underground services
Overhead transformers	Meters and meter installations
Overhead transformer installations	

Therefore, after considering your telegram, I fear that you have been misinformed on this particular subject.

The technical problems of distribution are constantly under discussion by our organization and this will naturally continue. These problems involve such references to costs as may be appropriate to an understanding of the engineering aspects of particular problems, but such discussions do not deal with overall costs of service, whether they relate to electric power, telephone, telegraph, railway, or other utilities. Costs of distribution necessarily include taxes, cost of financing, and many commercial and other aspects, often greatly influenced by local conditions, which fall essentially outside the engineering field; hence, discussions of such costs belong more properly to the activities of other organizations.

Our Institute is a professional engineering society, the objects of which, as defined in our constitution, are "the advancement of the theory and practise of electrical engineering and of the allied arts and sciences and the maintenance of a high professional standing among its members."

One of the principal methods of attaining these objects is by holding national, district, and local meetings for the presentation and discussion of electrical engineering and related subjects. Any member may submit for presentation and publication a paper upon any subject within the field of electrical engineering. The code of our technical program committee provides that "to be acceptable a paper should present information which adds definitely to the theoretical or practical knowledge of electrical engineering," and this code also specifies certain groups of subjects which are not regarded as suitable for Institute presentation, including the following: "As abstract propositions not directly connected with electrical engineering,—purely economic and allied studies such as rate making, project financing, obsolescence, depreciation, statistical methods, utility regulation, factory organization, etc."

Respectfully yours,

Signed W. S. Lee

News

Of Institute and Related Activities

Winter Convention's Ten Technical Sessions Each Reported Here Under Separate Heading

Edison Medal Presented to Dr. Conrad

PRESENTATION of the 1930 Edison Medal, highest award of the American Institute of Electrical Engineers, was made Wednesday evening, January 28, 1931, at a special meeting held in connection with the Institute's winter convention, to Dr. Frank Conrad of Pittsburgh, for his contributions to radio broadcasting and short-wave radio transmission. Dr. Dugald C. Jackson, past-president of the Institute, chairman of the Edison Medal Committee, and one of those who assisted in the founding of the award in 1904, briefly sketched the origin and history of the medal. The medal presentation was made by W. S. Lee, president of the Institute, following an inspirational address by Professor Charles F. Scott, past-president of the Institute, and Edison medalist in 1929. An abridgment of Dr. Scott's address follows:

Address of Dr. Chas. F. Scott

"This twentieth award of the Edison Medal is unique, in that the man so honored left school when he was but sixteen—a year before he might have entered high school—whereas all prior recipients of the Edison Medal have attended an institution of higher learning. On leaving school Frank Conrad got a job running a drill press making parts for Shallenberger ampere-hour meters; now, after forty years, this self-made scientist and engineer receives the distinguished service medal of his profession for his important contributions to its advancement.

"Just what differentiated this particular operator of an ordinary machine tool from scores of others in the same shop? What enabled this grade-school lad to meet successfully the competition of thousands of engineering graduates? And this in an age assailed by critics as reducing men to dull automatons! Many of his achievements have determined the course of electrical practise today; untold numbers of them have had an important influence. In the vernacular, this man has pulled himself up by his own boot straps. But what manner of man is this who although little-known to the public has made such a record? And what kind of straps, and what kind of a pull? To answer these questions it is necessary only to trace the man's life and work.

Conrad's Early Life

"What were the antecedents of the . . . boy, useful, ingenious, ambitious? Conrad's father was a railroad man,—a mechanic, a millwright having to do with upkeep and repair of machinery, steam engines and pumps, heating plant, lighting, batteries for telephone, and signals. He had sound ideas about developing boys for he saw to it that Conrad had something to do when not at school by providing him with simple tools and a place to use them—equipment . . . augmented by contributions from the scrap heap of the repair shop.

Facsimile of the face of the Edison Medal, highest A.I.E.E. award, made annually "for meritorious achievement in electrical science, electrical engineering, or the allied arts"

"Conrad learned the door-bell circuit; the ways of connecting battery cells together; he experimented with coils and improvised parts. He was curious about measuring electricity and made his own galvanometers. His mother's father was a civil engineer; Conrad quietly requisitioned his compass, wound a coil to complete a tangent galvanometer and had the satisfaction of a uniformly divided scale.

"Conrad's mother died when he was quite young and he lived sometimes with his father in Pittsburgh, attending the Starrett School, and at other times with his grandparents who lived in Altoona and had a nearby farm . . . But school was perfunctory. Lessons came easily, but the things taught did not excite interest or stimulate investigation and thought. School seemed a waste of time; he wanted to make a steam engine to run his toys or a galvanometer to measure his current. And so the boy brought with him to the laboratory a simple faith in nature's methods which the formal text book did not give . . .

"As co-worker . . . I have known Frank Conrad for many years . . . We met frequently during the twenty years we were together . . . in the same works; . . . in the subsequent twenty years . . . our long-time friendship has deepened . . . Accounts of his boyhood traits, of his development and methods, and of his engineering achievements, are not independent chapters but are interrelated in a single, progressive story.

Constructive Inquisitiveness

"Soon after Conrad began work on the drill press a significant incident occurred; he observed others who were working on arc lamps; he realized their difficulties and devised improvements. These are important steps—observation, analysis, invention . . . Subsequently he found out by trial why volts should not be measured with an ammeter. He made the personal acquaintance of choke coils, transformers, and condensers, and tried about everything he could think of with circuits and apparatus . . . Also he was engaged in studying algebra and geometry by himself . . .

. . . "H. P. Davis and Conrad worked together on the arc lamp, trying to induce it to give a reasonable performance on alternating circuits. The early induction-indicating instruments and watthour meter were large and expensive and although these lay outside of their official province, they undertook to study them as a sort of extra-curriculum activity. They developed a simple form of long-scale indicating instrument which is still used.

"Conrad then sought improvement of the watthour meter and . . . by a happy combination of painstaking study and intelligent cut-and-try . . . he evolved in 1897 the type of magnetic circuit which still is used in the "round-type" watthour meter.

Typical Radio Amateur

"The radio story is fascinating; it began in a simple, indirect way about 1914. A fellow engineer boasted a high-grade watch; . . . . in lunch-table discussion Conrad entered his mongrel timepiece in competition. Realizing that his watch would make a better showing if reset nightly by Arlington time signals he undertook to make a radio receiver, and presently had a crystal device by which he heard ticks. Uncertain whether it was Arlington, he improved his receiver, learned the Morse code, and found the ticks were the station call of a nearby amateur. Presently the Arlington signals made his watch the winner.

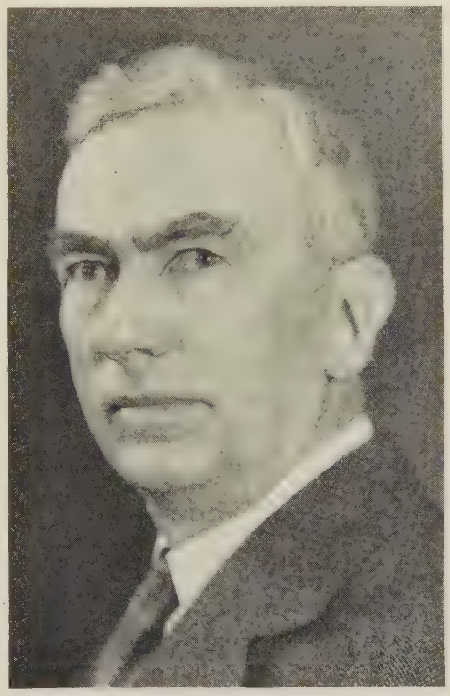
"Radio interest continued. His company took part in war activities and he was assigned radio problems and was in consulation in Washington, D. C. Among other achievements was a 1,000-cycle, 200-volt self-exciting generator for airplanes, weighing eleven pounds (much less than the French equivalent), encased with the radio equipment, and driven by a propeller. This was unique in being an American radio device which saw actual war service.

"Following the war, . . . Conrad had an experimental station at his home. One problem was to perfect apparatus for communication between the company's factories in different states. In these local tests his conversations and phonograph music were heard by neighboring amateurs; they liked music better than Morse code; they found the source and asked for more . . . The enterprise grew . . . Presently the studio was moved from garage to house and there were musical groups who were the original radio artists—predecessors of Damrosch and Amos 'n Andy . . . From neighborhood broadcasting came national broadcasting.

Genius

"Genius sometimes consists in selecting the thing which though simple is worth while. Among the innumerable wireless amateurs there was one who produced something different; one who attracted and interested others, and at some personal inconvenience contributed to their satisfaction and enjoyment . . . By painstaking observation and investigation in a discarded field Conrad discovered the characteristics of the short wave for extra long distance transmission and has made radio communication and broadcasting world-wide.

"In recounting these achievements it has been the aim to indicate how the subjects were taken up and how they were developed. Scores of other achievements might be mentioned covering methods of operation, pieces of apparatus, . . .



DR. FRANK CONRAD

Edison Medalist for 1930 who received the award "for his contribution to radio broadcasting and short-wave radio transmission"

grenades, and other war devices, and other items covered by some three hundred patents.

"Conrad's genius has had a propitious environment; the traditional inventor in the attic suffers for resources and sympathetic understanding; the modern counterpart is the organized laboratory force for industrial research.

An Individualist

"Primarily, Frank Conrad is an individualist. While cooperative he has not surrounded himself with a corps of assistants. He liked to work in his little shop at home and out of his hobbies and his home work have come some of his notable achievements.

"For many years Frank Conrad's official title has been assistant chief engineer of his company (Westinghouse). A few years ago he received the honorary degree of Doctor of Science from the University of Pittsburgh. The propriety of bestowing such a degree upon one who had no other degree was questioned and met by the reasoning: Granting that his career and achievements would have merited the proposed distinction had he an E. E. degree, was it not more creditable to have made such a record without it?"

Dr. Conrad Responds

After receiving the medal from the hands of President Lee and expressing deep appreciation, Dr. Conrad responded as follows, in part:

"Our present civilization can be said to be a product of comparatively few developments. The important ones which may be mentioned in the order in which they came into the world are, (1) printing, (2) the railroad, (3) the telephone, (4) the automobile, and (5) radio. Each of these has been an influence in molding the lives of people and has changed the destinies of nations.

"From early ages, the human race knew the need of implements to further their gregarious instinct. At first, man depended on muscular effort to travel and transport his goods on land; he early developed the art of water transportation from one land to another. Mechanical developments made the railroad possible and brought about mass movement. Then the automobile came as a more individualized form of transport. Printing, the telegraph, and the telephone made possible the direct exchange of ideas without the necessity of actual physical nearness. All of this has made possible our civilization wherein the individual may have the benefit of the sum total of the knowledge and products of his fellow beings.

Broadcasting Launched Fully Developed

"The arts mentioned, with the exception of radio, are not new to this age, but their usefulness has been made effective by the development of science, the uses and development going hand in hand. Radio broadcasting is distinctive in that it was scarcely visualized before the present century, but became a possibility from the developments of present day science. It has the unique distinction of having been launched as a fully developed

art. In the first year of broadcasting we had available all the artifices of the present day. It required no new conceptions to make possible its success. We have made advances in technique but they have been of a comparatively minor nature . . .

"One of the factors which made it possible for science to have ready nearly all the tools required for an entirely new art was the World War. Before the war, radio was considered as a possible rival of the telephone or telegraph, and its apparent field of greatest use was in communication from ship to shore, vessel to vessel, or with isolated spots. The desirability of communication between ships for even limited distances served as an impetus to the development of devices which would thus enable a ship in distress to call for help. The apparatus as developed before the war period effectively served this purpose although it would not make possible the use to which radio is put today. The military necessities of war times not only furnished the incentive for a further development, but what is even more important, furnished the financial support necessary for this work.

"At the close of the war we found ourselves in possession of the products of many research agencies, although there was no apparent use to which these products could be put. The tools were there but there was, so far as the world could see, no work for them to do. I personally experienced this situation in that I had facilities and equipment to carry on this art of radio communication, but no incentive to do it other than the natural fascination of working with a new tool. It is probable that by demonstrating to some of my friends the possibilities of this new instrumentality, we awakened to the fact that radio's field of usefulness was not between any two restricted points, but instead was over the widest possible area. Radio broadcasting, a new art, so came into being. . . .

"The progress of any development usually is one of slow evolution. The railroad at first was an exceedingly impractical and apparently impossible venture. . . . The telephone instruments which Bell exhibited at the Centennial Exposition in 1876 were workable devices and compared favorably with the instruments used for many years afterwards. Except for refinements that came in later years, Bell's equipment was probably the great major step in this development until the telephone borrowed from radio the vacuum tube, which device has made possible the intricate telephone systems of today.

What of Specialization?

"We should, of course, expect that any new development will progress relatively more rapidly than those that came in an earlier day, because each new development has the advantage of utilizing an accumulated storage of knowledge. We might ask: Is this store becoming greater than one individual mind can assimilate? An affirmative answer might be construed from the present tendency to specialization, but I hope we shall not specialize so thoroughly that some change in our environment will subject us to the fate of the highly specialized prehistoric animals who could not survive a change in the conditions suited to their particular existence. We, of course, may find the necessity of extreme specialization in present day sciences is not so real after all. . . "

Telegraphic Speed Reaches 2,500 Words per Minute

Telegraphy is the first commercial pplication of electricity on record. Unlike a great many of these early developments which long since have been di carded, telegraphy still is in the course of active development. During the first twenty years this development progressed to a remarkable degree—so far, in fact, that no further advance in the art was brought out until the comparatively recent extensive application of the vacuum tube. It is a tribute to the engineers of the time of Lord Kelvin that their work was carried out upon such a firm foundation that no further advances were made for such a long period. Five papers presented at the 1931 winter convention emphasized the efforts being put forth to increase speed and improve accuracy.

High-Speed Cables

A joint paper by J. W. Milnor and G. A. Randall, Western Union Telegraph Company, New York, showed some of the design characteristics and operating performances of high-speed ocean cables. It was demonstrated that now a transmitting speed of 1,400 letters per minute, simultaneously in both directions, is practicable; in uni-directional service a speed of 2,500 letters per minute is attainable. Indications are that the ultimate speed has not yet been reached, and that high-speed duplex operation is highly desirable, especially in cases where the installation of only one cable has been justified. However, in some cases—for example between America and Japan—the difference in time is such that most of the traffic naturally flows in one direction at a time, and it is better therefore to operate in one direction only in order to take advantage of the higher speed possible when operating that way. Usually where more than one cable is available part of the equipment is operated duodirectionally, and part uni-directionally, depending upon traffic conditions.

Interference

Any consideration of cable operating speeds, however, leads to a consideration of interference. This was shown in the other paper presented by Mr. Milnor. It is known that interference definitely limits the speed at which a cable can be operated. Such interference is caused sometimes by other nearby cables, and sometimes by power or railway systems in the vicinity of the cable terminals. The most troublesome form is that which in origin is chiefly natural, and may be likened to atmospheric disturbances commonly known as static.

The interference from natural causes is greatest at moderate frequencies, decreases with increasing depth of cable, is greatest at low latitudes, and also depends to some extent on cable design and shielding. This type of interference can be controlled to a considerable extent by installing a "sea earth" of the proper length, depending upon the local and economic conditions involved.

Cable Testing

An interesting dissertation was presented by F. B. Bramhall, Western Union Telegraph Company, New York, concerning a unique telegraph testing machine. The machine was shown to have a wide variety of uses, most important of which appears to be the measurement of distortion on telegraph lines, the study of telegraph relay operating characteristics, and the measurement of telegraph line efficiency.

The novel feature of this device is its recording mechanism through which the record is made by electrochemical action between the indicating needle and a chemically treated paper strip. The needle is in continuous contact with the paper but does not make a record until a potential is applied to it.

Private-Wire Service

A paper by W. B. Blanton, Western Union Telegraph Company, New York, dealt with the system now in use for handling messages in telegraph printer installations. This system was developed for the quick answering of calls, which is of extreme importance in high-speed transmission.

It was stated that in the new installation in New York, 1,600 circuits are being handled from 608 operating tables. The system has worked out so well that only a few seconds are required to answer a call,

and the total time of completing a message has been almost halved.

R. E. Pierce, American Telephone and Telegraph Company, New York, gave some interesting facts concerning the private-wire telegraph service maintained by the Bell system. (This paper was abstracted, beginning on page 45, of the Jan. 1931 issue of ELECTRICAL ENGINEERING.)

The session was presided over by H. S. Osborne, Transmission Engineer, American Telephone and Telegraph Company, New York, and vice-chairman of the A. I. E. E. committee on communication.

Higher Speeds Aim of Railway Motors

The only evening business session held in connection with the winter convention was devoted to the discussion of single-phase a-c. railway motors. The occasion was a joint meeting of the Institute's transportation committee and the Transportation Group of the New York Section.

Locomotives employing these motors have been in use by the New York, New Haven & Hartford Railroad Company since 1907, and from the standpoints of both operating experiences and maintenance costs are proving quite satisfactory. In an effort to provide for greater loads and higher sustained speeds intensive development work has been carried on in connection with these motors during the past few years. Two papers covering design details and operating characteristics were presented during this session—One by H. C. Jungk, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., and the second jointly by F. A. Pritchard and Felix Konn, both of the General Electric Company, Erie, Pa. A lively discussion followed in which almost every phase of operation with this type of motor was brought up by the numerous railway engineers present.

These two papers appear in abridged form beginning on pages 1009 and 1013 of the December 1931 issue of THE JOURNAL OF THE A. I. E. E.

HIGH TORQUE VS. HIGH SPEED

Mr. Jungk stated that the prime requirements for railway motors are high starting torque and high maximum running speed. The main difficulties in achieving this with the series a-c. motor were found to be in building a motor with sufficient poles to keep the flux per pole small, and still keep the armature diameter small enough to permit the desired running speed.

In Mr. Pritchard and Mr. Konn's presentation, a number of pictures were shown illustrating the structural details of these motors. Here again was emphasized the desirability of keeping the flux per pole small in order to minimize commutation difficulties but in addition was demonstrated how the application of interpoles and compensating windings to these motors also greatly improved commutation.

In addition to the items already mentioned, the following were pointed out:

1. Operating characteristics of single-phase, series, a-c. motors compare favorably with those of series, d-c. motors.

2. Commutator peripheral velocities up to 9,000 ft. per min. now are permissible with the use of the disk-spring construction.

3. Better core materials and more compact brush holders have permitted a large number of poles with small motor diameter.

4. More compact ventilation design now is obtained.

5. The use of roller bearings is an important aid in obtaining high speed.

6. Locomotives now being built with these motors have better operating characteristics at all speeds than do steam locomotives.

It was stated that it now is practical to build locomotives with single-phase series 25-cycle, a-c. motors (in twin) for an axle loading as high as 75,000 lb., and a maximum sustained speed of 90 mi. per hr. There is every reason to believe that should higher loading and increased speed be desired these limits can be exceeded.

From Inductive Interference to Inductive Coordination

Of significance is the fact that an entire session of the winter convention was devoted to a symposium covering the coordination of power and telephone plants. The session was presided over by A. E. Knowlton, associate editor of *Electrical World*, New York, and chairman of the Institute's meetings and papers committee, who said of the session:

"Actually the symposium has done more than assemble the elements of the problem into a comprehensive perspective, and thus serve as an interpretation for both power and telephone enterprises. It has demonstrated the ability of engineers to solve within their own sphere and that of precise economics, problems which otherwise would have brought into play the incompatible procedures of law. It also has demonstrated that engineers recognize their professional obligations to make available to the populace in general the fruits of technical accomplishment at minimum cost and maximum serviceability. Of all these performances the electrical profession may justly be proud."

PACK AND GHERARDI EMPHASIZE HARMONY

R. F. Pack, vice-president and general manager, Northern States Power Company, Minneapolis, in his introductory remarks, preliminary to the formal presentation of the technical papers, outlined briefly the history of the subject and the activities of the joint general committee of the National Electric Light Association and the Bell Telephone System, which has guided the destiny of this coordination work since 1921. On that initial foundation the various problems involved were approached in the broadest possible spirit of cooperation, bearing in mind the fact that the object to be attained was the removal of friction and the early development of mutually satisfactory construction and operating standards for these two types of utility systems. Mr. Pack said in part:

"It was recognized also that the public's interest is paramount and that both the power and communication utilities must be able to render their respective services to the public in an economical and efficient manner. . . . . We know now that the foundation stones have thus been well and truly laid. It was not so much what had actually been accomplished that mattered, but that the whole spirit of the relations between the telephone and power interests had been completely changed from one of friction, distrust, suspicion, and even of enmity, to one of confidence, good-will, and a desire on the part of both to cooperate. . . . . I am more and more convinced that this is the sound way to settle such problems and controversies arising between great interests in this country. Courts and regulating authorities approve this method because it promotes harmony and permits them to devote their time and talents to other useful purposes, and because it saves the taxpayers the material expense of costly technical hearings in which the interests of the public are in no way jeopardized."

In adding brief comments, Bancroft Gherardi, vice-president and chief engineer, American Telephone and Telegraph Company, New York, and past-president of the Institute tersely seconded Mr. Pack's remarks by characterizing the original state of affairs as "one in which the two utilities agreed on nothing, whereas now there was entire agreement as to the fundamentals involved, and a willingness to work in harmony" in solving detailed and specific problems. In emphasizing the economic value to all parties concerned including the users of utility services, of working out controversial problems on the basis of sound engineering judgment instead of fighting them out before courts and regulatory commissions, Mr. Gherardi cited the whole situation as illustrative of the broadening scope of the engineer and his work.

TECHNICAL PROBLEMS OUTLINED

The "Trend in Telephone and Power Practise as Effecting Coordination," dis-

cussed by W. H. Harrison, American Telephone and Telegraph Company, New York, and A. E. Silver, Electric Bond and Share Company, New York, is liberally abstracted elsewhere in this issue.

The "Status of Joint Development and Research on Noise Frequency Induction," was given by H. L. Wills, Georgia Power Company, Atlanta, and O. B. Blackwell, American Telephone and Telegraph Company, New York, who classified the factors contributing to induction in general and to noise frequency induction in particular, discussed methods of control, and outlined some of the further work to be undertaken. A similar dissertation concerning low-frequency induction was presented by R. N. Conwell, Public Service Electric & Gas Company, Newark, N. J., and H. S. Warren, American Telephone and Telegraph Company, New York, who gave a classification of factors responsible for inductive effects and discussed the various factors controlling the magnitude of induced voltages, their frequency of occurrence, and their duration and effect. Types of protective measures also were discussed at some length.

J. C. Martin, Middle West Utilities Company, Chicago, and H. L. Huber, American Telephone and Telegraph Company, New York, discussed the "Status of Cooperative Work on Joint Use of Poles," pointing out good and bad construction practises. (This paper is abstracted elsewhere in this issue.)

Industrial Subjects Attract Institute Attention

Electron tubes, automatic regulators, electrical distribution systems and special types of synchronous motors were included in the discussions presented during a winter convention session devoted to industrial power applications of electrical equipment.

High-Torque Synchronous Motors

A special "Synchronous Motor with Phase-Connected Damper Winding As a Drive for High-Torque Loads," was described by M. A. Hyde, Jr., Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This particular type of motor was described as having been designed to meet industrial requirements for low-speed synchronous motors such as are used in the drive of grinding machinery in the cement and mining industries. This type of motor is capable of developing extremely high starting and pull-out torque although the results obtained are bound up to an unusual extent in the control equipment which of necessity is somewhat more complicated than with the ordinary synchronous motor.

Some of the problems met in the design and application of synchronous motors to meet special industrial requirements were discussed by D. W. McLenegan and A. G. Ferriss, of the General Electric Company, Schenectady, N. Y. They presented the conclusions that the design characteristics of a normal type of synchronous motor best adapted for steady-load operation should include: (1) separate d-c. excitation, (2) internal revolving field, (3) laminated salient-field poles, (4) air-gap equal to from 1.5 to 2.0 per cent of the pole pitch, (5) amortisseur winding section of sufficient heat capacity to enable the motor to start its load safely, and (6) open armature slots somewhat fewer in number than those of an equivalent induction motor. They outlined methods whereby without abandoning this basic form the electric design of a synchronous motor may be so proportioned as to meet the characteristics required for many different exacting industrial applications.

Industrial Control and Power Distribution

J. H. Ashbaugh, Westinghouse Electric & Manufacturing Company, East Pittsburgh, outlined some of the many industrial operations in which the application of automatic regulators of one kind or another could be made advantageous. He explained the fundamental theory of all regulators and pointed out that any one regulator has a wide range of applications possible, stating as an example that a voltage regulator could be used just as well as a speed regulator or a current regulator. Mr. Ashbaugh asserted that one of the greatest needs was for a fully satisfactory and dependable speed regulator, and described a newly developed carbon-pile device developed for this service.

In discussing "Electrical Distribution Systems for Industrial Plants," Walter J. McClain, electrical engineer with Louis T. Klauder, consulting engineer, Philadelphia, outlined a method of compiling distribution problems and by analyzing these, determining a solution embodying general requirements suitable for an electrical system serving industrial plants. The scope of his consideration included everything from the source of power supplied to the power-consuming devices.

W. R. King, General Electric Company Schenectady, in his paper "Electron Tubes in Industry," gave an illuminating index to some of the rapidly increasing applications of various electron tubes. He touched briefly upon the theory and characteristics of photoelectric tubes and their application, discussed briefly the theory and application of the "pliotron," and discussed at some length the theory and application of the thyratron.

C. H. Drake, general engineer, Westinghouse Electric & Manufacturing Company, and chairman of the A. I. E. E. general power applications committee, swung the gavel during this session.

Traveling Waves and Lightning Effects Studied

In a winter convention session devoted to some of the problems incident to electric power transmission, two general subjects were discussed in five papers: (1) traveling waves on transmission systems and (2) lightning investigations of one character or another. The session was presided over by P. H. Chase, chief engineer of the Philadelphia Electric Company, and chairman of the Institute's transmission and distribution committee.

Continuing an extended investigation, L. V. Bewley, General Electric Company, Pittsfield, Mass., discussed further his investigation and calculations of "Traveling Waves on Transmission Systems." In the current paper Mr. Bewley presented the theory of traveling waves on multi-conductor systems and compiled a brief compendium on the general subject of traveling waves on transmission systems. The origin, shape, and general characteristics of traveling waves are discussed; equivalent circuits of terminal equipment and the corresponding reflections and refractions from such junctions were given for a large number of cases. Methods of computing a multiplicity of successive reflections by means of graphical lattices also were described. This latter is quite similar to the author's dissertation as presented at the 1930 Pacific Coast Convention at Portland, Ore.

Attenuation and Reflection

In discussing the "Attenuation and Successive Reflections of Traveling Waves," James C. Dowell, General Electric Company, Pittsfield, described a method which he had followed in segregating the individual waves from the oscillographic record of the voltage at a transition point due to the superposition of several successive reflections. In the author's opinion it is necessary to effect this separation to permit the determination of wave attenuation on a given transmission line. He stated that in the past it has not been unusual to at-

tribute the reduction in crest value of each successive reflection to attenuation, whereas the major cause of such reduction was reflection at the terminal equipment. The author presented analyses and calculations of the information revealed in certain oscillograms of successive reflection, and stated that his calculations demonstrated that by treating the line as distortionless the behavior of artificial lightning surges on a transmission line could be computed with a reasonable degree of engineering accuracy.

To supplement laboratory information on the subject, "Impulse Tests on Substations" of the Public Service Electric & Gas Company, Newark, N. J., were reported upon by R. M. Southgate and A. S. Brookes of that company, and E. R. Whitehead and W. G. Roman, of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., These practical tests on an operating system included the surging of a 220-kv. switching station over eight miles of overhead lines. A study was made of the effects of various amounts of connected bus and station equipment, and the effect of different arrester locations.

Field Data on Lightning

Further practical data were sought in a "Lightning Investigation on a Wood-Pole Transmission Line," reported upon by R. R. Pittman, Arkansas Power & Light Company, Pine Bluff, Ark., and J. J. Torok, Westinghouse Electric & Manufacturing Company, East Pittsburgh. As a result of field tests covering a total of 38 surges occurring on a highly-insulated wood-pole transmission line, the authors concluded that harmful effects are caused only by direct strokes. Of the 38 surges recorded, one reached a crest of 5 million volts and one a crest of 4½ million volts; analysis showed that these high surges were the results of lightning striking the line and causing faults between conductors but not to ground. Records obtained indicated that surge currents varied relatively from insignificant values to 100,000 amperes. The authors conclude that insulation alone does not offer a solution to the lightning problem.

Presenting his fifth annual paper on the subject of "Lightning Experiences on the 132-Kv. Transmission Lines of the American Gas and Electric Company," Philip Sporn, chief engineer of that company, discussed and analyzed the records of his system for 1929. Upon the basis of his own analyses the author has arrived at the conclusion that:

(1) Two-circuit lines are more reliable than single-circuit lines.

(2) Two ground wires are better than one.

(3) Grading shields do not reduce line outages, but decrease line damage.

(4) Direct and induced strokes must be considered.

(5) Flashovers do not concentrate on towers of high-footing resistance.

(6) Tower footing resistance must be low if an overhead ground wire is to give effective protection.

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Machinery Developments Emerge From Laboratory

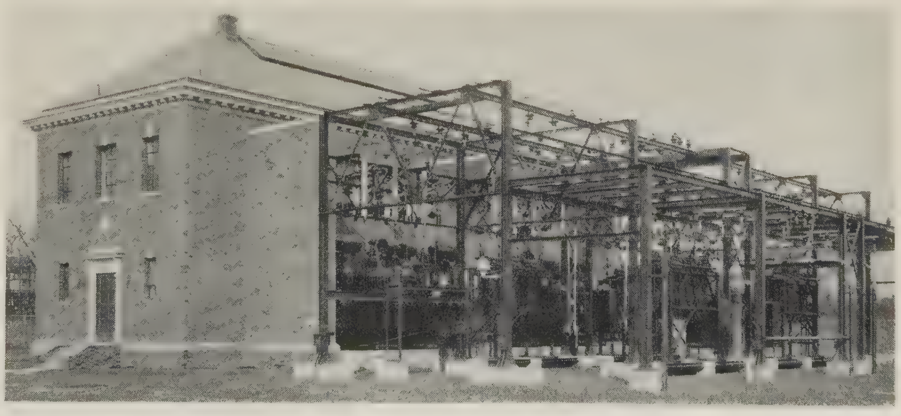
Five papers were presented at the machinery session of the winter convention, each recording a definite advance in the knowledge of electrical machinery performance. When asked for his impressions of the session, P. L. Alger, assistant to the vice-president in charge of design engineering, General Electric Company, Schenectady; chairman of the A. I. E. E. electrical machinery committee, and chairman of the session, said:

Mercury Arc Rectifiers

"Dr. A. W. Hull of the General Electric Research Laboratory described striking improvements in mercury arc rectifiers obtained as a result of extended research work, particularly on the control of current flow from the anodes. By the use of anode heaters to provide a definite mercury vapor pressure, the use of grids to increase the arc-back potential, and by other means the current-carrying capacities of rectifiers have been greatly increased, and the frequency of arc-backs has been materially reduced. New 3,000-volt rectifiers employing these new features now are in successful operation supplying all the power for the D. L. & W. electrification. In commenting on the paper, H. D. Brown, co-author with Dr. Hull, mentioned that the research work described had enabled the current capacities of rectifiers to be more than doubled in a brief time, and enabled very high momentary overload current ratings to be given. Mr. Brown also mentioned

Substation is Built in 70 Working Days

COMPLETION within 70 working days and with an average of 75 men on the job of the substation shown in the accompanying illustrations is the record established by the United Engineers & Constructors, Inc. The station was built at North Arlington, N. J., for the Public Service Electric & Gas Company (Newark, N. J.) and it is stated that notwithstanding the speed with which the job was completed the unit costs of carrying on the work were no higher than for other structures of similar design. The building is 70x30 ft., with the outdoor structure designed to accommodate four 26.4-kv. incoming lines, twelve 4.15-kv. automatically-regulated feeders, ten street-light circuits, and two 6,000-kv-a. transformer banks. At present two 26.4-kv. lines, six 4.15-kv. lines and two street-light circuits are in service.



that there is now under construction a 10,000 ampere, 625 volt rectifier.

"Gabriel Kron of the United Research Corporation, (Long Island City, N. Y.) presented a paper on the slot effects in induction motors, giving ten definite rules to predetermine vibration, "crawling," and noise. While this subject is a familiar one, and most designers have developed fairly satisfactory rules for their own use, Mr. Kron's paper presents for the first time a compact rational explanation of all these effects.

Stroboscopic Movies

"H. E. Edgerton, of the Massachusetts Institute of Technology electrical engineering staff presented a paper on the synchronizing performance of salient pole synchronous machines. His discussion was illustrated with a stroboscopic moving picture which showed the motion of the rotor as clearly as if the observer actually were carried around with the revolving flux, thus enabling the oscillations as the rotor pulls into step to be seen plainly. The solution of the salient-pole-machine synchronizing equation never has been obtained mathematically, because of its complex form, but Mr. Edgerton put the M. I. T. integraph to work on the task and with it obtained an exact solution in a form very convenient for use by designers. Discussion of the paper indicated that the results will be of immediate practical use in enabling the load synchronizing ability of synchronous motors to be accurately predetermined.

Heat Flow in Turbines

"C. R. Soderberg, Westinghouse Electric and Manufacturing Company, described a complete theory of steady-state heat flow in large turbine generators, which he has developed. The theory is based on laying out the heat-flow paths in the form of definite thermal circuits, and converting these into equivalent electrical circuits, the solution of which are in familiar form. The proportions of the total heat dissipated from the various machine surfaces were discussed, and a future paper giving experimental results was promised.

"The last paper of the session was one dealing with the effects of transient voltages on power transformers, by K. K. Palueff of the General Electric Company. This paper is the third in a series written by the author, presenting the theory and practical results of shielding as a means of reducing the voltage concentration in transformer windings under lightning and switching surges. The first two papers dealt with two-circuit transformers solidly grounded, and grounded through an impedor, respectively, while this latest paper deals with the auto transformer. The theoretical and experimental results presented show that it is possible now, by proper shielding, to control the surge voltage distribution throughout the windings of all of these types of transformer, thus greatly reducing abnormal voltage stresses and permitting simpler insulation design."

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Protective Devices Improve Electric Service

Developments in circuit-interrupting devices and theory easily occupied the center of the stage in the winter convention session on protective devices; not, however, to the exclusion of presentations concerning transient stability limits of power systems and current advances in lightning arrester theory and application, which also claimed general interest.

Lightning Protection

J. J. Torok, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., described "An Experimental Lightning Protector for Insulators" the operation of which was said to be similar to that of the expulsion fuse, causing the extinction of the arc at the end of the first half-cycle when the current goes through zero value. The supporting principle is that excessive potentials will set up an arc in the confining chamber, which arc is subsequently extinguished by a deionizing effect in a remarkably brief period of time, thus clearing the system of what otherwise might be a troublesome flashover.

In "Field Tests on Thyrite Lightning Arresters Using Artificial Lightning of 1,500,000 Volts" described by K. B. McEachron and E. J. Wade, General Electric Company, Pittsfield, Mass., the authors had studied that type of arrester in experimental operation on a 45-mi. transmission line. As a result of experimental findings it is proposed that line insulation shall be limited for a distance of a half-mile back from the station at which lightning arresters are installed. Oscillograms were interpreted to show that for the traveling wave used, no protection is offered by an arrester at a distance of 2,180 ft.

System Stability

In suggesting the "Series Resistance Method of Increasing Transient Stability Limits," R. C. Bergvall, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., characterized it as an "ace in the hole" of some importance in effecting station system stability, particularly in connection with hydroelectric generators of relatively low inertia as compared with the system load inertia. He presented evidence to support his contention that synchronism could be maintained readily on a hydro system of normal proportions for any type of fault if, through a combination of high-speed circuit breaker and high-speed relay operation, a series resistor of suitable proportions could be inserted in the generator neutral lead for a brief period of time.

Circuit Breaker Trends

In discussing "The Trend in Development of Modern Circuit Interrupters," J. B. MacNeill, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., reviewed briefly the major mechanical and electrical characteristics of all important contemporary devices including some foreign types. Mr. MacNeill stated that through the use of the modern high-power testing facilities now available to engineers, many of the now novel ideas for such interrupting devices may possibly be developed commercially. It is his conclusion that the several forms of circuit interrupters not using oil and which now are assuming commercial importance, should be limited in application to insulations of 25 kv. or less, and largely for indoor service only. For higher voltages he sees little competition with the oil circuit breaker in its present greatly improved forms.

"The Oil-Blast Circuit Breaker" (see page 134, Electrical Engineering, February 1931) was described at some length by D. C. Prince and W. F. Skeats, General Electric Company, Schenectady. Extensive field and laboratory tests on this breaker itself and in comparison with other types, were described at length in a paper by Philip Sporn and H. P. St. Clair, of the American Gas & Electric Company, New York, and in a paper by R. M. Spurck and H. E. Strang, General Electric Company, Philadelphia. These latter two papers presented field and laboratory test results upon the basis of which the General Electric authors stated in part that:

"A high-voltage, high-capacity breaker now has been demonstrated to have the ability to interrupt forty short circuits up to 115 per cent of its rating in a short period of time without inspection or attention and still be in condition to operate. This would indicate that in some respects the general impression of an oil circuit breaker as an unreliable device and one requiring undue maintenance may be subject to revision. Such a development appears to meet the requirements set up only a few years ago by some operating engineers for a breaker that would operate 50 times under short circuit without requiring attention."

In commenting upon the session its chairman, Raymond Bailey, assistant electrical engineer of the Philadelphia Electric Company, chairman of the Institute's protective devices committee said, in part:

"Discussion of the oil circuit breaker papers indicated a disagreement between the research engineers of American manufacturers, on the underlying theory of circuit interruption in oil. This frank discussion of opposing views should prove particularly valuable in arriving at the final solution of the oil circuit breaker problem."

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Welding Session Studies Arc Characteristics

Of importance and particular significance in the field of electric welding is the trend of research and investigation toward a better understanding of the basic fundamentals underlying the electric arc itself. While the cut-and-try method based upon field experience and laboratory tests has been responsible for some noteworthy improvements in both welding equipment and procedure it stands to reason that a more intelligent and economical solution to many of the problems of that arc may be expected when the basic fundamentals of the electric arc itself are better understood. In recognition of the prominent place occupied by electric welding in the field of engineering activities is evidenced by the fact that one entire session of the winter convention program was devoted to that subject under the chairmanship of P. P. Alexander of the General Electric Laboratory, and chairman of the A. I. E. E. welding committee.

The principal contribution of fundamental research was in the discussion of "Some Experiments With Arcs Between Metal Electrodes" presented by Prof. G. M. Shrum, University of British Columbia, Vancouver, B. C., and H. G. Wiest, Jr., General Electric Company, West Lynn, Mass. and presented by Dr. Saul Duschmann, General Electric Company, Schenectady. The paper described experiments on arcs occurring between metal electrodes in argon and other gases, in which the current was controlled by means of a kenotron. Volt-ampere characteristics of the discharge for the entire transition stage from glow to arc, or the reverse, were obtained by varying the temperature of the cathode in the kenotron. According to observation the spectrum of the discharge in the arc phase is characteristic of the cathode material, at least for the smaller current values. Results obtained led the authors to state that they did not support the assumption that a temperature effect at the cathode and the resulting thermionic emission causes the glow discharge to develop into an arc. Rather, the indication is that the resulting arc is a matter of current density of the cathode.

Arc-Welding Equipment

Arc welding generators and related equipment in one form or another were discussed at some length in three papers:

1. An Improved Arc-Welding Generator, by J. H. Blankenbuehler, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

2. The Neutralized Welder—A Means of Controlling Transients, by Frederick Creedy, Lehigh University, Bethlehem, Pa.

3. A System for D-C. Arc Welding, by S. R. Bergman, General Electric Company, West Lynn, Mass.

Mr. Blankenbuehler attributed most of the trouble in starting and maintaining arcs to the operating characteristics of the welding generator involved, and presented an analysis of these troubles explaining them in terms of generator design. He described equipment including a specially designed transformer built into the circuit of a welding generator in such a manner that surges due to arc variations are practically obviated.

These three papers presented various experimental data—mathematical and of other analyses—and the results of a certain amount of practical experience. Suggestions covering the use of transformers, reactors and special machine design in varying combinations, all intended to take the peaks out of the short-circuit characteristic curves of welding generators were made by the authors. The resulting general discussions and barrage of claims and counter-claims somewhat clouded the issue so far as it concerned the accurate determination of just which one of the several ideas was conceived first or worked best. However, the consensus of opinion seemed to be that the general trend of the suggested development, and certainly the objective were correct.

Welding Methods

A method for the "Resistance Welding of Motor Frames," discussed by Malcolm Thomson, General Electric Company, Lynn, Mass., involves the use of a flash-welding process which appears to be particularly successful in this application.

The author of this paper described the process of making motor frames from flat plates rolled into cylindrical form and butt-welded by the flash process; with feet welded on by ordinary arc welding. He added that these two welding methods made possible the production of motor frames from 25 to 50 per cent cheaper than with corresponding steel castings besides adding the definite advantages of greater uniformity in dimensions and structures.

Equipment and procedure for "Electric Resistance Brazing," were described by Samuel Martin, Jr., General Electric Company, Schenectady. Equipment developed includes a special portable transformer unit complete with service extension cord, leads of convenient length, and a specially-designed brazing clamp or tongs. Soft carbon blocks are used in the tongs as the heating elements, and the metallic parts to be brazed are clamped between them, receiving all of their heat according to the author, by conduction. With this equipment and the use of silver solder, joints of much greater mechanical strength, durability, and higher electrical conductivity than the more usual soft solder joints, were said to result with an actual saving in cost per joint.

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Research Forms Basis For Further Development

Seven subjects, principally of a fundamental nature and revealing some noteworthy results of continued persistent efforts, were presented and discussed in a winter convention session devoted to research. L. W. Chubb, assistant to the vice-president of the R. C. A.-Victor Corporation, and chairman of the Institute's research committee, presided.

Oil Characteristics Sought

"Some Electrical Characteristics of Cable Oils" were outlined by Hubert H. Race, General Electric Company, Schenectady, who divided his presentation into three parts. His first section dealt with routine measurements of d-c. resistivity and described a quartz-insulated testing cell and portable testing set for use with it, with which it is claimed that absolute resistivity between 1×10^9 and 1×10^{13} ohms per cm.^{3} can be measured at any temperature up to 150 deg. cent. In his second section he gave data concerning the variation of the apparent d-c. conductivity of a heavy cable oil with potential gradient and with temperature showing that the conductivity is constant only for very low gradients. His third section was a summary of variations of dielectric coefficients and dielectric loss, occurring with temperature and frequency as observed for a viscous cable oil. His analysis shows that the total dielectric loss is the sum of two components, one due to conduction and the other qualitatively explained by Debye's theory of polar molecules.

In a companion paper, J. B. Whitehead, of The Johns-Hopkins University, Baltimore, presented some of the results of his further investigation into "The Conductivity of Insulating Oils." Dr. Whitehead concluded that:

(1) Certain high-grade insulating oils have electrical characteristics similar in type and comparable in magnitude to those of the carefully refined, poorly-conducted liquids used in physical research.

(2) In the purest state they show a definite though brief dielectric absorption.

(3) The initial dielectric absorption increases with decrease of temperature and thus is associated with the viscosity.

(4) The dielectric loss at less than 60 cycles alternating stress is determined definitely by the continuous-current characteristics within the interval from zero to 0.1 sec.

(5) The initial absorption conductivity and subsequent decay are not completely accounted for by the residual impurities as frequently stated.

In collaboration with Dr. Whitehead, Prof. W. B. Kouwenhoven, The Johns-Hopkins University, presented a paper on on "Fundamental Properties of Impregnated Paper." The authors jointly emphasized the importance of the initial conductivity of impregnated oils as distinguished from the final conductivity and stated that higher conductivity is reflected in increased losses arising from both reversible and irreversible dielectric absorption.

Vacuum Tubes Control Traffic

Traffic-control equipment operated automatically by light beams, one of the many and ever-increasing commercial applications of the versatile vacuum tube was described by R. C. Hitchcock, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The equipment is described fully elsewhere in this issue.

Commutation in Hydrogen

Two papers having to do with research looking toward the improvement of rotating machinery, were presented by R. M. Baker, and G. M. Little, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. As the result of experimental data collected by Mr. Baker concerning "Commutation and Current Collection in Hydrogen," he has come to the conclusion that:

(1) A commutator machine designed and adjusted for good commutation in air will operate satisfactorily and give good brush life in hydrogen.

(2) If a commutator machine must spark in hydrogen the brush life may be increased materially by maintaining less than 10 per cent humidity.

(3) Contact resistance between carbon brushes and commutator may be lowered materially by the introduction of hydrogen.

(4) Carbon or graphite brushes cannot be operated satisfactorily on plain tool-steel slip-rings running in hydrogen and that

(5) contact drop between a carbon or graphite brush and a brass slip-ring may be as much as ten times higher with the ring running in air as it is with the ring running in hydrogen.

Mr. Little has been investigating "The Application of the Helical Groove to Slip-Rings and Commutators," and has come to the conclusion that the helical groove:

(1) provides a means for forcing a more uniform distribution of current over the brush face; (2) permits the escape of air trapped under a brush; (3) prevents local spot heating under overload conditions; (4) raises the content drop of the brush, improving commutation and (5) in some cases increases brush life.

A rather comprehensive paper by C. G. Suits, General Electric Company, Schenectady, covering his "Studies in Non-Linear Circuits" and a discussion of the "Magnetic Circuit Units as Adopted by the I. E. C." prepared by Dr. Arthur E. Kennelly, Harvard University, brought the research program to a close.

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Railroad Electrification Problems Are Discussed

Of the five papers presented at the transportation session of the winter convention, two may be said to be of general interest in the field of transportation, and three of somewhat specific interest in that field. In commenting upon the session, Sidney Withington, electrical engineer of the New York, New Haven & Hartford Railroad, chairman of the Institute's committee on transportation, and chairman of the session said, in part:

Mr. Moreland's paper was especially timely in that it followed closely the inauguration of one of the notable projects of the year in railroad electrification. The comprehensive description, together with the inspection trip, presented to the Institute members a somewhat unusual opportunity to learn the details of the Lackawanna electrification. Mr. Drake's paper on the Sperry fissure detector car also was timely and may well be considered a tribute to the late Elmer A. Sperry.

The five papers presented were:

1. Lackawanna Suburban Electrification, by E. L. Moreland, Jackson & Moreland, Boston.

2. Motive Power for Suburban Electrification, by Charles Kerr, Jr., Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

3. Transverse Fissure Detector Car, by H. C. Drake, Sperry Products, Inc., Brooklyn, N. Y.

4. Inclined Catenary Calculations, by B. M. Pickens, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

5. Design of Catenary System for Cleveland Union Terminal, by N. F. Clement and E. E. Richards, Cleveland Union Terminals Company.

Mr. Moreland's paper is rather fully abstracted elsewhere in this issue.

Mr. Kerr dwelt upon the problems peculiar to suburban electric railway operation where the number of cars required during rush hours varies from two to six times that required for off-peak service. He pointed out that trailer cars may be used to advantage under these circumstances without reducing the schedule speed more than three or four per cent.

In discussing this paper, H. F. Brown of the New York, New Haven & Hartford Railroad stated that for twenty years his road had used a system similar to that which Mr. Kerr outlined, and that it worked out very well.

Faulty Rails Revealed

In introducing Mr. Drake, Mr. Withington paid tribute to the late Emler A. Sperry who was directly responsible for the development of the rail-fissure detector described in Mr. Drake's paper, and one of the last of the many contributions which Mr. Sperry has made to civilization. This presentation was illustrated by a moving picture which showed the effectiveness of the device in locating all kinds of transverse rail faults and fissures before the point of actual rail breakage. As many as 24 fissures have been found in a single rail section.

In Mr. Pickens' absence Mr. Kerr read an abstract of his paper. This paper demonstrated a unique method for calculating the space factors involved in the design and layout of inclined overhead catenary construction as required in electric railway work. His method provides for a smooth, continuous curve of contact wire from span to span, lying in a horizontal plane.

The Cleveland Union Terminal is a station which is used jointly by the several railroads entering Cleveland, and is located in a central part of the city; the electrification, which is of the 3,000-volt d-c. type, extends from the terminal some distance out in both directions, covering a total of 59 track miles. The last paper of this session explained the design details of the overhead power supply used on this electrification. The scheme consists of tangent-chord compound catenary system. Parabola formulas were used for the calculations and where feasible were made up in the form of charts.

In discussing all of the papers of this session, D. C. Jackson brought out the point that the problem involved in

electric railway construction and operation was primarily one of transportation, and that the electrical engineering work involved was chiefly a means to the furthering of that end. According to Mr. Jackson the most important question to be answered is an economic one; "will the improvements possible through electrification justify themselves from a cost standpoint?"

Winter Convention Attracts 1,589 Registrants

With devotion of its special attention to inductive coordination, and industrial applications of electricity and electrical devices, the winter convention, held Jan. 26-30, inclusive in the Engineering Societies Building, 33 West 39th Street, New York, N. Y., attracted 1,589 persons, officially registered, but heavy attendance at the sessions indicated the presence of many others. As revealed by the following tabulation nearly every geographic district was represented:

District	Registrants
New York City and Foreign (3)	730
Middle Eastern (2)	515
North Eastern (1)	231
Great Lakes (5)	47
Canada (10)	42
Southern (4)	11
South West (7)	10
North Central (6)	3
Total	1,589

New York Sights are Shown to Convention Delegates

In addition to its wealth of technical papers covering a wide variety of timely and important subjects, the winter convention program offered a multiplicity of entertainment features in keeping with the quality of its technical program. Inspection trips included the recently electrified divisions of the Delaware & Lackawanna Railroad and its power supply facilities; the new Hudson River Bridge, the longest single-span structure in existence; and the Empire State Building, the world's highest. Also available to all conventioners, practically at their own convenience, were such features as the Westinghouse Lighting Institute; the Chrysler Building (exceeded in height only by the Empire State Building) with its vertical distribution network; modern photo lithograph and newspaper plants; the Electrical Testing Laboratories; and various immense steam-electric generating plants, not to mention the museums and exhibitions peculiar to New York.

Particular attention was given to the women's entertainment program which included charmingly conducted luncheons and bridge teas, to say nothing of inspection trips specially chosen for their unique attractiveness, including a visit to the White Star Line Steamship "Majestic" and a practical demonstration of television at the Bell Telephone Laboratories.

For the men, if attendance be any index, the informal buffet dinner and supper was a huge success, and there truly was "standing room only" at the "The Frolics of 1931," the nine-part headliner stage show put on by the entertainment committee. Concluding the social affairs in connection with the convention was the annual dinner dance held in the Grand Ballroom of the Hotel Astor, Thursday evening, January 29, and presided over by that genial personage, President Lee.

A. I. E. E. Directors Meet During Convention

The regular meeting of the Board of Directors of the American Institute of Electrical Engineers was held at Institute headquarters, New York, Wednesday, January 28, 1931, during the annual winter convention of the Institute. Those present were:

President—W. S. Lee, Charlotte, N. C.

Past-presidents—R. F. Schuchardt, Chicago, Ill; Harold B. Smith, Worcester, Mass.

Vice-presidents—W. S. Rodman, Charlottesville, Va.; C. E. Sisson, Toronto, Ont.; G. C. Shaad, Lawrence, Kans.; I. E. Moultrop, Boston Mass.; H. P. Charlesworth, New York, N. Y.; T. N. Lacy, Detroit, Mich.

Directors—F. C. Hanker, East Pittsburgh, Pa.; E. B. Meyer, Newark, N. J.; J. Allen Johnson, Buffalo, N. Y.; A. M. MacCutcheon, Cleveland, Ohio; J. E. Kearns, Chicago, Ill.; F. W. Peek, Jr., Pittsfield, Mass.; C. E. Stephens, New York, N. Y.; A. B. Cooper, Toronto, Ont.; A. E. Knowlton and R. H. Tapscott, New York, N. Y.

National treasurer—W. I. Slichter.

National secretary—F. L. Hutchinson, New York, N. Y.

Present by invitation—H. A. Kidder, New York, chairman of the committee on the engineering profession.

Actions Ratified

Minutes of the directors' meeting of December 4, 1930, were approved.

Reports of meetings of the board of examiners held December 23 and January 20 were presented, and the actions taken at those meetings were approved. Upon the recommendation of the board of examiners, the following actions were taken upon pending applications:

391 Students were enrolled.

486 applicants were elected to the grade of Associate.

27 applicants were elected to the grade of Member.

25 applicants were transferred to the grade of Member.

4 applicants were transferred to the grade o f Fellow.

The board ratified the action of the finance committee in approving for payment, monthly bills amounting to $33,253.52 for the month of December and $30,159.22 for the month of January.

The annual report of the president of the U. S. national committee of the International Commission on Illumination was received and ordered filed, and payment of the Institute's annual contribution of $300 to the U. S. committee was authorized.

In accordance with Sec. 22 of the constitution, N. T. Wilcox was exempted from future payment of dues, thereby being added to the list of "Members for Life."

The national secretary reported that the members in arrears for dues for the fiscal year which ended April 30, 1930, were dropped from the membership list on December 31, 1930, with the exception of those who had requested an extension of time for the payment of these dues. The members dropped totaled 739 including 2 Fellows, 40 Members, and 697 Associates.

1932 Institute Meetings

The committee on coordination of Institute activities reported a recommended schedule of national and district meetings for the calendar year 1932, based upon applications for meetings received from district executive committees in response to a request of the coordination committee that such applications be filed by January 1,1931. The schedule included all requests for meetings that were received. The Board voted to approve the recommended schedule of meetings for 1932, as follows:

January 25-29, Winter convention, New York, N. Y.

March 14-16, District meeting (No. 5), Milwaukee, Wis.

May (early), District meeting (No. 1), Providence, R. I.

June 20-24, Summer convention, (location to be decided later).

Aug. 29-Sept. 2, Pacific coast convention, Vancouver, B. C.

October, District meeting (No. 2), Baltimore, Md.

November, District meeting (No. 4), Memphis, Tenn.

Upon request of the executive committee of the North Eastern District, the dates of the Rochester district meeting were changed from May 6-9, 1931, to April 29-May 2, 1931.

New Section

Upon the recommendation of the sections committee, the territory of the Louisville section was extended to include the remainder of Woodford County and all of Fayette and Jessamine Counties, and a new section was authorized; namely, a Florida section, to include as its territory the entire state.

As recommended by the committee on student branches, authorization was given for the organization of student branches at the University of Illinois, Urbana, Ill., and Rice Institute, Houston, Tex.

Standards Specifications

Upon recommendation of the standards committee, approval was given to the following specifications developed by the sectional committee on insulated wires and cables:

Specification No. 12—Weatherproof (weather-resisting) Wires and Cables.

Specification No. 12A—Heat-Resisting Wires and Cables.

Specification No. 4—Code Rubber Insulation for Wire and Cable for General Purposes.

These specifications were approved for publication in the regular A. I. E. E. series of pamphlets dealing with standards and related material.

Miscellaneous Actions

Amendments to the By-laws were adopted, changing the following references therein to conform to changes in names which have already gone into effect: "Journal of the A. I. E. E." changed to read "Electrical Engineering," "Engineering Foundation, Inc." changed to read "United Engineering Trustees, Inc.," "Engineering Societies Research Board" changed to "The Engineering Foundation."

Appointment of two representatives of the Institute on the Council of the American Association for the Advancement of Science for the year 1931 was referred to the president.

The designation of delegates to attend the annual meeting of the American Academy of Political and Social Science, Philadelphia, April 17-18, 1931, was referred to the president.

A communication from the Museum of Science and Industry, Chicago, enclosing an outline of proposed exhibits in the museum on the subject of electric power and asking for comments, was referred to the Chicago Section of the Institute.

It was voted to hold the March meeting of the board of directors in Pittsburgh, during the district Meeting of the Institute, March 11 to 13.

Other matters were discussed, reference to which may be found in this and future issues of Electrical Engineering.

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Some Winter Convention Discussions are Summarized

A SUMMARY of some of the many discussions presented at the first four sessions of the winter convention is given herewith. Only discussion submitted in writing in accordance with A. I. E. E. rules governing it is summarized; complete discussion together with all papers so approved will be published in the Transactions. A list of papers presented was published in the January issue of Electrical Engineering. Later discussions will be summarized in subsequent issues.

Symposium on Telegraphy

E. R. Shute discussed "Newfoundland-Azores Duplex Cable." Referring to Fig. 1 of the paper he pointed out that this cable forms the diagonal of a quadrilateral, and in the event of a cable failure or stoppage of any of the cables the resulting triangular circuit layouts tend to maintain continuity of service.

Interference

A. W. Breyfogel discussed "Submarine Cable Telegraphy—Influence of Interference." He stated that the paper gives the theoretical as well as the practical means for determining the magnitude of the effect that transient forms of interference will have upon the receiving instrument; but it does not give the practical means available for minimizing the effect of such disturbances. Where interference is present, it is always of advantage to tune the receiving equipment to the lowest practical frequency consistent with reception of satisfactory shaped signals. This generally permits reception at a higher speed than might otherwise be obtained.

Transmission Testing Machine

H. H. Haglund in his discussion on "Telegraph Transmission Testing Machine" stated that the machine has many other uses besides the testing of telegraph transmission. It is used for comparing the speed of oscillating systems of comparatively low frequency such as electrically-driven tuning forks. Mr. Haglund told of five methods which in the past have been so commonly employed for this purpose.

P. B. Shanck in his discussion on "The Telegraph Transmission Testing Machine" believed that the machine is particularly well suited to the investigation of distortion which, with a regularly-recurring signal, oscillates through a definite cycle so as to form a regular pattern as is the case with a-c. interference.

Printing Concentrator

C. M. Brentlinger, in discussing "A Printing Telegraph Concentrator" explained that the concentrator was developed to give very fast service without incurring prohibitive operating expense. He also pointed out in his discussion the advantages of splitting circuits into several 100- or 200-wire units instead of putting them all in one large unit. These are as follows: space limitations imposed by the need of other equipment before each operator, a saving in cable expense, a possible saving effected in the provision of equipment to care for future growth, and greater flexibility of operation.

Private-Wire Service

H. H. Nance discussed "Modern Practises in Private-Wire Telegraph Service" with special reference to the operation of voice-frequency carrier telegraph systems on channels of carrier-telephone systems. He cited the value of the flexibility of this method that resulted when line trouble encountered during a recent severe storm in the mid-west caused the re-routing of service.

Symposium on Coordination of Power and Telephone Plant

J. J. Smith in discussion of "Trends in Telephone and Power Practise As Affecting Coordination" did not believe that the references in the paper to the use of transformers with graded insulation and Y-Y transformers were representative of

the more usual type of practise on power systems. A large proportion of 220-kv. transformers are so constructed but for 66-kv. systems and above, a large proportion of the transformers have sufficient insulation on the neutral end of the winding to permit the insertion of considerable impedance between line and ground. He also pointed out that the use of delta-Y instead of the Y-Y connection is by far the more common practise.

Noise-Frequency Induction

In discussion of "Status of Joint Development and Research on Noise-Frequency Induction," J. J. Smith predicts the introduction of the use of vacuum tube devices on a fairly large scale within the next decade. He also calls attention to fact that some of the work of the Joint General Committee is of interest in other fields, such as electrical machinery, elimination of street noise, etc.

M. D. Hooven in discussion of the papers in the symposium called attention to the educational value of the material presented, and in particular, with reference to the problem of low-frequency induction. He also cited the importance of cooperative advance planning which was expressed in the last three papers of the symposium.

W. W. Lewis read a discussion prepared by L. T. Robinson on the papers in the symposium and which brought out the fact that a similar problem exists in the relation of the use of radio to other electrical industries. The three factors defined in the papers—namely "Influence Factor," "Susceptiveness Factor" and "Coupling Factor"—also exist and have the same importance in the radio communication field.

Low-Frequency Induction

H. S. Phelps discussed "Status of Joint Development and Research on Low-Frequency Induction." He remarked "that the paper should be most helpful to one called upon to outline the essential feature of low-frequency induction." In further discussion he commented upon the benefits of the shielding effects that may be derived from the proper use of ground wires.

L. P. Ferris discussed "Status of Joint Development and Research on Low-Frequency Induction." Showing the effect of diminishing-earth conductivity on the permissible closeness of power and telephone lines with the aid of a curve prepared from field data, and by considering a hypothetical case.

H. M. Trueblood discussed "Joint Development and Research on Low-Frequency Induction." He explained that the division of the work is such that some of the project committees are engaged upon questions relating very largely to telephone systems, while others are giving their attention to questions which concern power systems almost exclusively. Each project committee is made up of members representing both industries so that the power and telephone engineers are getting pretty well acquainted with each other's problems.

D. H. Gage discussed "Status of Joint Development and Research on Low-Frequency Induction," with relation to the interference on telegraph lines as caused by power lines. He believed that there is a field for investigation in cases where unexpected interference results from an exposure of a communication line to an apparently well-balanced power circuit, with very little current in the neutral. He also cited a situation where short exposures at different places on the same line which while alone would not cause serious interference, but when they were combined in certain ways, materially affected the operation of communication circuits.

Joint Pole Use

D. H. Gage also discussed "Status of Cooperative Work on Joint Use of Poles" and brought out the question of joint-line agreements with particular reference to the character of circuits on jointly-used poles; also the question of liability. He believed engineers should give these questions careful consideration, even though they might seem outside the scope of an engineering study.

Protective Devices Session Discussion

Stability

S. B. Crary in discussion of "Series Resistance Method of Increasing the Transient Stability Limit" pointed out that the practical gain to be realized from the use of the series-braking resistor decreases with faster switching time.

J. W. Anderson in his discussion of this paper gave some actual figures of acceleration serving to emphasize the marked tendency of hydroelectric generators to overspeed upon loss of load immediately after a short circuit occurs. This was pointed out by Mr. Bergvall in his paper.

G. D. Floyd, discussing "Series Resistance Method of Increasing the Transient Stability Limit," believed that from the calculations and tests covered by the paper, zero resistance at point of fault might be inferred. He pointed out that the inference is justified for three-phase faults, but in cases of single- and double-line-to-ground faults where there might be high resistance at fault location, the added resistance in the generator leads might cause a drop in the unit's speed sufficient to make it lose synchronism.

H. S. Phelps in discussion of "Series Resistance Method of Increasing Transient Stability" took exception to the idea expressed in the paper that instead of trying to solve the stability problem by building lightning-proof lines consideration might be given to building lower-cost transmission lines that would be expected to flash over. He pointed out that this conclusion must be considered in conjunction with the views expressed in the symposium on coordination of power and telephone plants.

Circuit Interrupting Devices

Philip Sporn discussed "Trend in Development of Modern Circuit Interrupters" and commented upon the advances made within the last three or four years in the oil circuit breaker field. He expressed disappointment, however, in the lack of progress in the development of an oil-less interrupting device.

C. L. Fortescue in discussion of "Trend in Development of Modern Circuit Interrupters" commented on the various principles of oil circuit breakers, emphasizing the noiselessness and smoothness with which the deion circuit interrupter and the deion-grid oil circuit breakers operated.

R. M. Spurck in discussion on this paper commented upon the attempts that have been made to eliminate oil from high-duty circuit-interrupting devices. He believed that although workable devices not requiring oil have been developed there is a question whether or not the entire elimination of oil does not introduce some handicaps which are greater than those it has tried to eliminate.

Philip Sporn in discussion of "Oil Circuit Breaker Tests—Philo 1930" pointed out that the present OCO-two minutes-OCO breaker duty cycle does not meet actual operating conditions or practise. He expressed a need of bringing Institute standards and service practise into closer conformity.

J. B. MacNeill discussed "The Oil-Blast Circuit Breaker" and he pointed out that some of the ideas advanced in the paper seemed to be at variance with well-established facts about arc behavior He believed that at some point on the arc. tip the arc would form a crater which would move about but never permit the arc to envelop the tip. In consequence the oil and gas would rush past the arc, partly into the hollow electrode and partly out the explosion pot throat, through the regular contact clearance instead of passing through the arc as claimed in principle in the paper.

In discussion on "Field Tests on Standard and Oil-Blast Explosion Chamber Oil Circuit Breakers," H. M. Wilcox cited a number of tests that have been made on

oil circuit breakers equipped with deion grids. The average performance of the deion-grid circuit breakers on all of these tests ranged from 7,000 to 8,000 volts per inch, with a grand average of 7,500 volts per inch of total arc length as compared with a performance of 4,050 volts per inch on the 140-kv. tests of the oil-blast circuit breaker under average circuit conditions.

Power Transmission Session Discussion

Traveling Waves

C. L. Fortescue's discussion on "Traveling Waves on Transmission Systems" was read by J. J. Torok. He expressed interest in finding that in making computations, Mr. Bewley used the method of successive reflections; he further stated that to determine proper clearances, etc., for lightning calculations this method is simple and direct and is sufficiently accurate.

H. L. Rorden's discussion of "Traveling Waves on Transmission Systems" was read by J. G. Lusignan, Jr., who emphasized the importance of experimental verification of mathematical treatment and described tests of traveling waves made with the cathode ray oscillograph. The results obtained with line conditions as given by Fig. 10D of Mr. Bewley's paper were illustrative of the general correlation found.

O. Ackerman's discussion of "Attenuation and Successive Reflections of Traveling Waves" was read by E. Beck, and pointed out the results of this paper as pertaining to attenuation which deviated from any previous results reported. Figs. 12 and 13 of the paper indicate that in a travel of 85 microseconds, corresponding to about 16 mi. surges decrease only 10 to 20 per cent. Previously reported tests indicated that surges over a 16-mi. stretch attenuate to about one-half their original value.

L. V. Bewley read a discussion which E. W. Boehne prepared on this paper. In the light of information gathered from field observations it pointed out one additional way in which corona affects the attenuation of voltage surges.

Lightning Investigations

L. V. Bewley in discussion of "Impulse Tests on Substations," commented upon the fact that the paper gives a number of oscillograms showing the effect of bus structure, breakers, and transformers, on traveling waves; however, conclusions were not drawn as to the characteristic effect of station equipment on traveling waves.

L. V. Bewley in discussing "Lightning Investigation on a Wood-Pole Transmission Line" gave the definitions and derivations of the self- and mutual-surge impedances of the equivalent conductor which replaces any number of conductors in parallel.

C. L. Fortescue's discussion on "Lightning Investigation on a Wood-Pole Transmission Line" was read by Mr. Garnett. He pointed out that Fig. 11 in the paper cannot possibly be a cathode ray oscillograph record of what happened on the line itself as on either side of the lightning experimental station 4½ mi. distant, the line was provided with fused drain points having a flashover of from 800 to 1,000 kv. for long surges. He asserted that the record was false, and that it was due to something influencing the cathode ray oscillograph circuit directly instead of through the line.

E. C. Williams read a discussion prepared by C. E. Ambelang and F. E. Andrews on "Lightning Investigation on a Wood-Pole Transmission Line." In this they reported their experience with lines of voltage lower than those of 110-kv. investigated by the authors, but their experience substantiates that cited in the paper; their conclusions also correspond.

J. J. Torok discussed "1929 Lightning Experience on the 132-Kv. Transmission Lines of the American Gas and Electric Company." He analysized the author's data, interpreting it on a direct stroke basis. In further discussion J. J. Torok stated that the paper shows markedly the importance of adequate ground-wire protection. He predicted that if two ground wires properly located were used instead of one on the Turner-Logan Line, the number of flashovers would be reduced from thirteen to one or two.

R. N. Southgate discussed "1929 Lightning Experience on the 132-Kv. Transmission Lines of the American Gas and Electric Company." He described a case where a lightning stroke was photographed, and then located as having struck the ground about 2,000 ft. from the station. The location of this stroke was placed within 350 ft. of a 220-kv. line to which an oscillograph was connected, and within 275 ft. of the live 132-kv. line. A surge was not recorded and a trip-out on the 132-kv. line did not occur, which indicates immunity of lines of this nature from induced strokes and lends support to the direct-stroke theory.

L. V. Bewley discussed "1929 Lightning Experience on the 132-Kv. Transmission Lines of the American Gas and Electric Company." One of the points which he explained and illustrated mathematically was that a flashover on the bottom conductor might be due to a direct stroke on the ground wire rather than an induced surge.

A summary of some of the discussions of the papers presented at the later sessions of the convention will be given in a subsequent issue.

A. S. T. M. To Meet in Pittsburgh

A regional meeting and dinner of the American Society for Testing Materials will be held in Pittsburgh at the William Penn Hotel March 18, 1931. The program constitutes a symposium on welding, and the Pittsburgh section of the American Welding Society is in cooperation.

The sessions include:

1. General survey of welding processes
2. Welding processes applicable to aluminum
3. The quality of materials for fusion welding
4. Modern applications of arc welding
5. Recent developments in gas welding and cutting
6. Stethescopic examination of welded products
7. Tests of welding made by the Watertown Arsenal
8. Magnetic methods of testing butt welds
9. Fatigue and impact testing of welded products
10. Welded inspection.

Rutgers University Plans European Tours

Russia with its new experiments and many aspects of engineering as well as of industrial management, will be the object of practical observation and study by a party which will tour that country during the summer of 1931 under the leadership of Parker H. Dagget, dean of the college of engineering at Rutgers. It is planned also that a party of educators and travelers studying social conditions will make the tour through Russia and Europe under the direction of Prof. N. C. Miller, head of the Rutgers University Extension Division.

The tour now is being organized with headquarters at Rutgers University, New Brunswick, N. J., the expectation is to visit in addition to Russia, cities in Germany, Austria, France, Sweden, Finland, Denmark, Switzerland, and Poland. The entire group is scheduled to sail from New York July 4, 1931.

Turbine Inventor Chas. Parsons Passes Away

Sir Charles Parsons, K. C. B., inventor of the steam turbine design bearing his name, passed away February 11, 1931, while aboard ship on a West Indies cruise. He was 76 years old.

The steam turbine upon which he began experiments in 1884 represents but one of his many contributions to science and mechanics. Sir Charles evoked much comment while visiting in the United

States in 1924, when he made a plea for the founding of an international corporation to dig twelve miles into the crust of the earth. He contended that the water power supply of the world was being depleted rapidly and that it might be possible to harness the heat that lies deep beneath the surface of the globe.

During the World War Sir Charles served on numerous government committees. He was knighted in 1911. Later he served terms as president of the Institute of Physics, the British Association, and other similar organizations. Among the many scientific awards received by him was the medal of the Royal Society, of which he was a fellow. Sir Charles was chairman of the numerous industrial corporations which manufactured his turbines and other inventions.

Lehigh University to Hold Welding Symposium

The subject of welding and its progress each year in process and equipment. is comprehensively handled in the welding symposium presented annually by Lehigh University. This year the symposium will be held on Friday, March 27th; and one of the important papers will be that presented by J. C. Hodge of the Babcock & Wilcox Company. Mr. Hodge has made important improvements and contributions to the art of welding, and is in position to speak authoritatively concerning this important branch of engineering activity.

In addition to the discussion, there will be many demonstrations of all of the different types and methods of welding; and this year a special feature, which will reflect the most recent progress in the art in accordance with scientific development, will demonstrate the equipment and process of testing welds by gamma rays.

The success of the symposium in advancing the art of welding has been evidenced in the past by the heavy attendance of engineers from many industrial districts.

Research Assistantships Offered by U. of Illinois

To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen research graduate assistantships in its engineering experiment station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry.

Appointments are made and must be accepted for two consecutive collegiate years of ten months each, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. Half of the time of a research graduate assistant (approximately 900 clock hours for each ten-month period) is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study.

Nominations to these positions, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the Director of the Station each year not later than the first day of April. Preference is given those applicants who have had some practical engineering experience following the completion of the undergraduate work. Appointments are made in the spring, and they become effective the first day of the following September. Additional information may be obtained by addressing The Director, Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Business Conditions Reflected by "Indicators"

The following table of "selected business indicators" gives a comprehensive view of the business situation at the beginning of February. It is a new and easily understood tabulation, devised by a conference of statisticians in industry which meets once a month under the auspices of the National Industrial Conference Board, Inc., New York.

The conference represents more than 8,000 industrial firms throughout the United States and its statistics are compiled each month for the preceding month.

SELECTED BUSINESS INDICATORS

	Jan. 1931 expressed as percentage of: Dec. 1930	Oct. to Dec. 1930 average	Jan. 1930
Basic Production			
Auto. U. S. A. and Canada	114	122	64
Building contracts	91	81	70
Steel ingots[1]	119	103	65
Pig iron[1]	103	89	60
Bituminous coal	98	95	78
Machine tool shipments	88	89	41
Machine tool orders	100	93	37
Copper, N. and S. America	96	91	77
Cotton cloth, standard	108	105	78
Newsprint paper	102	97	87
Electric power	102	100	94
Basic Consumption			
Steel orders unfilled	105	112	92
Cooper shipments	86	87	86
Machine tool orders unfilled	88	80	32
Crude rubber	133	119	78
Silk taken by manufacturers	89	98	68
Stocks on Hand			
Crude rubber	103	109	116
Copper in U. S. A	98	97	121
Raw silk in storage	89	98	68
Newsprint paper	104	95	149
General Trade			
Carloadings, total	106	89	86
Merchandise and miscellaneous	104	86	88
Advertising lineage, newspapers	93	86	86
National magazine cost	71	64	87
Retail Trade			
Department stores[2]	106	103	93
Mail order[2]	86	84	
5 and 10 cent stores[2]	115	115	105
Business failures, number	131	149	120
Business failures, liabilities	113	145	155
Wholesale prices, general[3]	99	97	83
Wholesale prices, raw materials	101	98	80
Wholesale prices, semi-manufactured	97	96	78
Wholesale prices, finished	98	96	86

1. Average daily basis.
2. Corrected for monthly variation.
3. Estimated.

North Eastern District Meets at Rochester Apr. 29

A four-day meeting of the North Eastern District of the A. I. E. E. will be held at Rochester, N. Y., April 29 to May 2, 1931. Headquarters will be at the Sagamore Hotel.

The city of Rochester possesses many features which should prove most interesting to visitors attending the meeting; geographically located on the southern shore of Lake Ontario, and built upon the banks of the Genesee River falling 261 ft. in three cataracts within the city limits, it has all the natural resources which go to make a city attractive. From an industrial point of view Rochester is an important manufacturing center. It is the home of such well-known plants as the Eastman Kodak Company, the General Railway Signal Company, and the Stromberg-Carlson Telephone Manufacturing Company.

Technical Sessions

Four technical sessions which have been tentatively planned by the local committee will be built around: (1) Selected Subjects, (2) Research, (3) Symposium on Noise in Electrical Machinery, and (4) General Distribution. At these sessions many interesting papers will be presented, several of them dealing with the subject of lightning in relation to distribution systems.

A list of the papers to be presented and more complete details of the meeting will appear in the April issue of Electrical Engineering.

Mining Engineers Register Another Successful Annual Meeting

With a general attendance of over sixteen hundred members and guests the 140th annual meeting of the American Institute of Mining and Metallurgical Engineers meeting in the Engineering Societies Building, 29 West 39th St., closed February 19th proclaimed by all in attendance as thoroughly successful. The year's progress in mining and metallurgical fields had been definitely and interestingly presented and discussed; entertainment occupied a liberal portion of the program and two medal awards and one prize award conferred for distinguished service.

William H. Pierce, vice-president of the American Smelting & Refining Co. who has made abundant contributions to the art of mechanical casting, electrolytic refining, and copper converting, notably the Smith-Pierce basic converter, which has long stood supreme, received the James Douglas Medal for his numerous designs and improvements of devices and machinery for smelting, refining and rolling copper. This medal was established by anonymous donors to commemorate the work of Dr. James Douglas, twice president of the Institute of Mining engineers and an earnest worker for the cause. The William Lawrence Saunders medal, awarded "for distinguished achievement in mining" was conferred upon Francis William Maclennan, the second McGill University man to win it since it was established in 1927.

The Robert Woolston Hunt prize and medal, won by Doctor E. C. Bain in 1929, this year went to one closely associated with Doctor Bain in much of his work—Edmund Sharington Davenport, research engineer for the Eastern Malleable Iron Company, the Westinghouse Lamp Company, and now with the United States Steel Corporation at Kearny, N. J. His studies have dealt specifically with cast iron, tungsten, thorium, and the transformation of autinite at constant subcritical temperatures.

The election of officers for the ensuing year makes Robert E. Tally, executive vice-president in charge for the United Verde Copper Company, New York, director and president; Howard N. Eavenson, consulting engineer, Pittsburgh, and H. A. Guess, managing director of the American Smelting & Refining Company of New York, directors and vice-presidents; and Louis S. Cates of the Phelps Dodge Corporation, Karl Eilers, consulting metallurgist, S. R. Elliott, general superintendent of the Cleveland Cliffs Iron Company, Ishpeming, Michigan, H. G. Moulton, consulting engineer, New York, and William Wraith, of the Inspiration Consolidated Copper Company and the Andes Copper Mining Company of New York, directors.

Personal

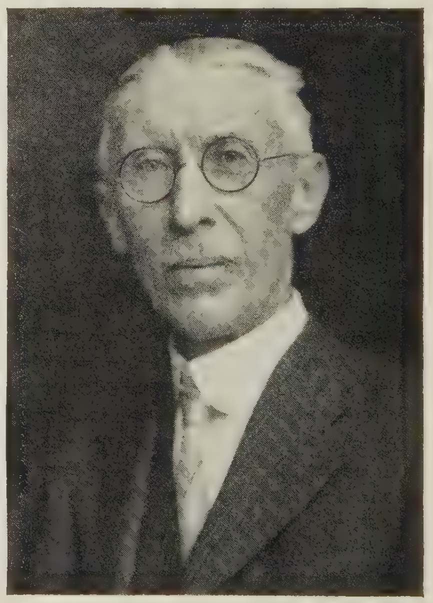
William J. Foster is Awarded Lamme Medal

Dr. William J. Foster of Schenectady, N. Y., has been awarded the Lamme Medal of the American Institute of Electrical Engineers "for his contributions to the design of rotating alternating current machinery," and will be presented at the summer convention of the Institute which is to be held in Asheville, N. C., June 22-26, 1931.

William James Foster, Sc. D., consulting engineer (retired) General Electric Company, was born in Argyle, N. Y., September 17, 1860. His college preparatory work was done partly alone with borrowed textbooks and partly at an academy and a boarding school. After graduating from Williams College with an A. B. degree in 1884, he remained a year for advanced work in mathematics. During the next five years, he taught high school subjects, and made an intensive study of physics. The degree of Master of Science was conferred upon him by Cornell University in 1891, following a year of graduate study.

In the summer of 1891, Dr. Foster began his engineering career in the Thomson-Houston Works in Lynn, Mass.; a few months later he was assigned work on synchronous converters. On October 1, 1892, he became assistant engineer, and began at that time a close association with Dr. H. G. Reist which continued for thirty-seven years.

Beginning in 1893 and extending through several years, his association with Dr. Steinmetz also was very close. During this period, Dr. Foster assisted in general improvements, developed retardation tests, and originated tests for measuring short-circuit losses. His drafts of test methods involving heat runs, overloads, temperature rises, etc., through Dr. Steinmetz were submitted to the Committee on Standardization of the A. I. E. E. and adopted as standards.



DR. WILLIAM J. FOSTER

During most of his engineering life he has had general charge of the electrical designs of a-c. rotating machines, built by the General Electric Company. For about twenty-five years, beginning in 1895, he made practically all the calcula-

tions on the most important generators that were built by this company.

He joined the Institute in 1907, and was transferred to the grade of Fellow in 1916. He served as a member of the Committee on Electrical Machinery for ten years, and was Chairman during the year 1928-29.

His other memberships include the American Association for the Advancement of Science and Phi Beta Kappa.

E. C. Stone Named Vice-President Philadelphia Co.

E. C. Stone, vice-president of the Institute, was appointed on February 1st assistant to the senior vice-president of the Philadelphia Company and its subsidiaries.

Mr. Stone is a native of Charlestown, N. H.; following graduation from Harvard University in 1904, he immediately became affiliated with the Westinghouse

E. C. STONE

Electric & Manufacturing Company at East Pittsburgh as an engineering apprentice, later entering the engineering department engaged in the design of transformers. In 1911 he joined the Allegheny County Light Company in Pittsburgh which two years later became the Duquesne Light Company. In 1913 he organized the system operating department for the lighting of the city of Pittsburgh, acting until 1919 as system operator; then he was promoted to the office of technical assistant to the general manager. In 1922 he became planning engineer, a position in which he organized and developed the planning division. In 1927 he again received promotion to become system development manager.

Mr. Stone has just relinquished his duties as chairman of the engineering national section of the National Electric Light Association. He is a member of the advisory board of the International Electrotechnical Commission and a member of the Association of Iron and Steel Electrical Engineers and the Engineers Society of Western Pennsylvania.

E. A. Hester, formerly planning engineer of the Duquesne Light Company has been placed in charge of the newly formed operating systems planning division of the company's vice-president and general manager's office, taking over the previous duties of E. C. Stone, former system development manager.

B. M. Jones, formerly general engineer of the Duquesne Co. has been promoted to planning engineer, the position vacated by Mr. Hester, and will be directly responsible for the planning and orderly development of company system and the preparation of the annual capital improvement budget.

Richard H. Ranger has entered consulting engineering practise, to specialize in radio, acoustics, and general electronic technique. With him are four of his former associates in the Radio Corporation of America. The R. C. A. retains him in matters of radio picture transmission.

Previous to joining the R. C. A. ten years ago, Major Ranger was Commanding Officer of the Signal Corps Laboratories at Fort Monmouth. His first work in the R. C. A. was building the long wave, transatlantic receiving stations of that company—notably that at Riverhead, Long Island. Subsequently, he built the first R. C. A. broadcasting station at Aldene, N. J., and started the broadcasting stations, WJZ on top of the Aeolian Building, and of WRC in Washington. He was identified also with the first ship-to-shore telephony on the S. S. *America*.

Frank W. Smith, vice-president, general manager, and a director of the United Electric Light & Power Company and chairman of the board of the New York and Queens Light and Power Company, two of the five companies composing the New York Edison System, has been made a vice-president of the New York Edison Company. Mr. Smith is very much of a pioneer in the arc light field; when a lad of thirteen he engaged with the United States Illuminating Company, and by the time he had reached the age of sixteen, had become general clerk. In 1889 when the United Company was formed, he was paymaster, and at twenty-four, assistant auditor. Since 1912 he has been a vice-president of the Brush Electric Illuminating Company, having priorly served both this company and the United Company as secretary.

Clarence L. Law, general commercial manager of the New York Edison Company and assistant to vice-president of the Yonkers Electric Light & Power Company was elected president of the Electrical Association of New York at its recent annual meeting. As general secretary, director, treasurer, and president of the Illuminating Engineering Society, Mr. Law is a prominent figure in the electrical industry; he also has served the National Electric Light Association as chairman of numerous committees, and has been active in the Empire State Gas and Electric Association, American Institute of Electrical Engineers, Association of Edison Illuminating Companies, and American Association for the Advancement of Science.

Roy Wilkins, according to ratification by the stockholders of the Pacific Electric Manufacturing Company, San Francisco, has been appointed its vice-president in charge of engineering. Mr. Wilkins joined the organization Jan. 1, 1928 in a consulting capacity, and for fifteen years prior to that date had been associated with the Pacific Gas and Electric Company; he has conducted many hydroelectric and high-voltage experiments and is well known to the industry for his corona research and his knowledge of high-voltage oil circuit breakers. He has always taken an active part in Institute affairs and those of the Pacific Coast Electrical Association.

Douglas Montgomery, who was previously electrical engineer in Pasadena, California, has been for the past year, lacking some three weeks, in Buenos Aires with the Western Electric Company, Inc. of Argentina, (local foreign subsidiary of the Electrical Research Products, Inc.), operating as service supervisor for the company's Buenos Aires district. Mr. Montgomery has been "seeing to it that from 18 to 38 motion picture installations kept their company voices in any one of the several languages—Spanish, French, English, or German."

Frank B. Steele, until recently vice-president and general manager of the Utica Gas & Electric Company, Utica, N. Y., has opened offices in that city for the general practise of engineering. Mr. Steele will specialize in heating, power, electrical and pumping problems, tests and reports on private industrial power plants, design of steam, hydro, heating and pumping plants and transmission, substations and distribution systems. After eleven years in its service he resigned as an officer of the Utica utility two years ago. He is a member of the

A. I. E. E., N. E. L. A., and the American Gas Association.

◆

L. M. Cargo, Mountain States representative of the Westinghouse company, Denver, Colo., whose election to the presidency of the Electrical League of Colorado is announced, is a real veteran in the electrical business, having been continuously with the same firm for 42 years, 33 of which have been spent in the Rocky Mountain region.

◆

Byron E. White of the Utica Gas & Electric Company has been named division engineer of the central division of the Niagara Hudson Power System. Mr. White's appointment follows more than 25 years' experience in the engineering department of the Utica Gas & Electric Company.

◆

J. G. Corrin, who has been with the transformer division of the Allis-Chalmers Manufacturing Company in Los Angeles, has resigned to join American Brown Boveri Company, Inc., in New York City, as a special transformer representative. Mr. Corrin went to the Pacific Coast from New York seven years ago; he was formerly district manager for the Pittsburgh Transformer Company, later joining Allis-Chalmers when that company took over the Pittsburgh company.

◆

Robert S. Hale, long associated with the Edison Electric Illuminating Company of Boston, has resigned. Mr. Hale was a graduate of Harvard and obtained his M. E. degree at Cornell. From 1893 to 1895 he was assigned to special engineering work with the Boston Edison Company and from 1910 has been in charge of the special research department, where, as an authority on utility economic problems, he became widely known throughout the electrical industry.

◆

S. P. Larsen, for the past four years northwest manager of the Line Material Company, Portland, Ore., has been made district sales manager in the Northwest for Hubbard & Company, pole-line hardware manufacturers of Pittsburgh, Chicago, and Oakland, Calif. Mr. Larsen will transfer his headquarters from Portland to Seattle.

◆

Otto Snyder, president of New York Power & Light Corporation and in charge of eastern division activities of the Niagara Hudson Power Corporation System, at the February 5th meeting of its board of directors was elected a vice-president of Niagara Hudson system.

◆

George E. Deming, works manager of the Philadelphia Storage Battery Company, has been named as its executive vice-president and Walter E. Holland, chief engineer, becomes vice-president in charge of engineering.

◆

J. R. Murphy has received appointment as manager of the General Electric Company at Spokane, succeeding Bernhard Olsen, who has been transferred as local manager of the company's Indianapolis office.

◆

Harvey H. Hoxie has been appointed San Francisco manager of the Joslyn Company of California. Mr. Hoxie has been associated with the San Francisco office of the company for some time.

◆

Mathew S. Sloan, at the organization meeting of the board of directors of the New York Edison Company, was re-elected president.

Obituary

C. L. Doub, assistant engineer of the Reading Company and an Associate of the Institute (1922), died at the age of thirty-four, January 21. Mr. Doub was born at Washington, D. C., and was a graduate of Johns Hopkins University. In 1918 he became substation operator for the Hagerstown & Frederick Railway, Maryland, but continued to study in a Westinghouse graduate student course, which he completed in 1920. Prior to joining the Reading Company, he was assistant engineer of the Illinois Central Electrification Work. His affiliation with the Reading Company dated back to 1927.

◆

Harry B. Alverson, for the past thirty years a member of the Institute, and for a long period identified with the Buffalo General Electric Company as its electrical engineer, died on January 25th after an illness of several weeks. He had left the Buffalo General Electric shortly before he was taken ill and was apparently well on the road to recovery when he suffered a relapse.

A native of Portage, Wisconsin, he was graduated from the University of Wisconsin in 1893. This was followed by a course at Cornell University.

He was an active member of the Institute's Niagara Frontier Section, and his death terminates a long and useful professional career.

◆

Elwood F. McLaughlin, district manager of the central station department of the southeastern district of the General Electric Company, Atlanta, Ga., died in the local hospital of that city on January 8th, following an attack of pneumonia. He was a prominent and popular member of the Institute's Atlanta Section; one upon whom the Section's officers always could depend for wholehearted cooperation. Mr. McLaughlin was born in Philadelphia and at the time of his death was forty-seven years of age. He was graduated with the class of 1905 from Pennsylvania State College and immediately entered the steam turbine testing department of the General Electric Company at Lynn, Mass.

He was a member of the A. S. M. E., had served as chairman of its Atlanta section, and always took a leading and active part in all local enterprises of both A. I. E. E. and A. S. M. E. plans. He was a member also of the Atlanta Athletic Club, entering into its work with the same vigor and enthusiasm which typified all of his affiliations. He first joined the Institute in 1922.

◆

John Lundie, president of the Lundie Engineering Corporation, New York City, and an Associate of the Institute since 1899, died at his home on Seventy-Second Street after an illness of several weeks. He was 73 years old,—a noted consulting engineer and inventor of many railway devices bearing his name:—the Lundie tie-plate, rheostat, duplex rail anchor and the "telfer," a combined electrical hoist and traveler. Mr. Lundie was born in Arbroath, Scotland, obtained his early education there, and received his Bachelor of Science degree from Edinburgh University in 1880. This was supplemented by an honorary degree of Doctor of Science conferred by the same university in 1902. From 1873 to 1877, while still pursuing his studies, he was engaged in harbor work at Dundee. Immediately after leaving the university at Edinburgh, he came to this country, spending the next four years employed in railroad engineering in Oregon and Washington. From 1884 to 1890, municipal work in Chicago claimed his attention;

this was followed by three years of bridge construction work. In 1893 he began his practise as consulting engineer.

Doctor Lundie was a member of the American Society of Civil Engineers, the American Association for the Advancement of Science, the American Institute of Consulting Engineers, the American Iron & Steel Institute, the Knights Templars, the New York Railroad Club, the New York Athletic Club and was a Fellow of the Royal Society of Arts.

◆

O. E. Huebner, electrical engineer of Russell & Stoll Company, New York City, and an Associate of the Institute (1918) died recently. He was born in Halle, Germany, in the year 1880. Much of his later time has been devoted to research problems, the dissemination of some of his attained results being made through the columns of *Engineering News*. The pycnotic substance theory and its practical application, another of Mr. Huebner's investigations, found publicity in *Technologist*, organ of the German American Technical Societies.

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the addresses as they now appear on the Institute records. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the Secretary at 33 West 39th St., New York, N. Y.

Davis, R. H., Westinghouse E. & M. Co., East Pittsburgh, Pa.

Dawson, Leonard L., 98 Looker Ave., Springfield, N. J.

A. DiLucci, Box 1051, Chicago, Ill.

Gale, R. E., 706 N. 19th St., Boise, Idaho.

Charles T. Gilliam, Central Power & Light Co., Frost Nat'l. Bank Bldg., San Antonio, Tex.

Kigar, D. F., 1403 Minnie St., Port Huron, Mich.

Lieb, Adolph W., N. Y. Edison Co., 393 7th Ave., New York, N. Y.

Mahnke, E. Chris, 1400 E. 53rd St., Chicago.

Prehn, Victor N., 940 Broad St., Newark, N. J.

Sherwood, W. E., Kew Gardens, 2700 Que St. N. W., Washington, D. C.

Sliney, David, 11 Orchard St., Cranford, N. J.

Van Wyck, P. V. R., Summit, N. J.

Vreeland, F. P., 110 E. 176th St., New York.

Williams, Clifton S., Research Lab., Westinghouse E. & M. Co., East Pittsburgh, Pa.

Local Meetings

Gaseous Tubes For Illumination Purposes

On March 3, 1931, the Illumination Group of the New York Section will hold a meeting on the subject of "Gaseous Tube Lighting,"—of great interest at present when so many noteworthy developments of it have taken place within the last few months. To bring section meetings up to date on a matter which is receiving so much attention a symposium has been arranged. The three speakers all intimately connected with this phase of electrical engineering, to each present a fifteen-minute résumé accompanied by striking demonstrations; also, there will be ample opportunity for open discussion. The subjects and speakers will be as follows: "A Brief Résumé of the History of the Development of Gaseous Tube Lighting," by D. C. McFarlan Moore, consulting engineer; "High-Tension Cold Cathode Gaseous Conduction Lamps," by Leo Beck, chief engineer, Claude Neon National Laboratory; "Hot-Cathode Gaseous Conduction Lamps," by Ray D. Mailey, vice-president, General Electric Vapor Lamp Company.

The meeting will be held at 7:30 p. m. in Room 1, Fifth Floor, Engineering Societies Bldg., 33 West 39th Street, New York, N. Y.

◆

Intercommunication For Ships at Sea

The Communication Group of the New York Section will hold a meeting on the evening of March 10 for the discussion of "Communication Facilities of Ships at Sea." Two speakers have been selected to present the subject as follows: "Ship-to-Shore Radio Telephone Systems," by Frederick R. Lack, Bell Telephone Laboratories, Inc., New York, N. Y., and "Ship-to-Shore Radio Telegraph Systems," by George H. Clark of the Radio Corporation of America, New York, N. Y. There will be ample time for discussion. The meeting will be held in the auditorium of the Bell Telephone Laboratories, 55 Bethune St., (corner of West Street) New York, N. Y., and will be called to order at 7:30 p. m.

By courtesy of the Laboratories, dinner will be served in the cafeteria from 6:00 p. m. on, to members and guests at a charge of 75 cents, and during the period preceding the meeting sound pictures will be presented in the auditorium.

Developments In X-Ray Science

Dr. A. Mutscheller, director of research of the Westinghouse X-ray Company, will be the speaker at the next general meeting at the New York Section to be held at 8:15 p. m. on March 27 in the Engineering Auditorium, 33 West 39th Street, New York, N. Y.

Renowned for his contributions in the field of X-ray, Doctor Mutscheller will trace the progress from early beginnings, pointing out some of the problems which have been overcome in bringing this science up to its present highly developed state. He will describe some of the recent and outstanding accomplishments—among them the hot-cathode high vacuum valve which has made possible the generation of extremely high voltage direct current—and will discuss the various applications of the modern X-ray in the industrial and scientific world.

The lecture will be followed by a demonstration of the Lenard cathode ray tube showing some of the more spectacular results achieved today by the X-ray.

Future Section Meetings

Cleveland

March 19, 1931—Industrial Applications of Vacuum Tubes and Photoelectric Cells, by E. L. Manning, General Electric Research Laboratories, Schenectady, N. Y.

April 16, 1931—Human Relations in Industry, by Whiting Williams. Joint meeting with Student Branch of Case School of Applied Science, at which two papers will be presented by students.

Detroit-Ann Arbor

March 17, 1931—The Sound of a Shadow, by J. B. Taylor, General Electric Co.

April 21, 1931—1,000-Deg. Turbine, by Paul W. Thompson, Detroit Edison Co. Meeting to be held at the Detroit Edison Auditorium.

Lehigh Valley

March 27, 1931—Adventures in Science, by E. L. Manning. Meeting to

be held at Sterling Hotel, Wilkes-Barre, Pa.

April 24, 1931—Ladies' Night, to be held at Americus Hotel, Allentown, Pa.

Niagara Frontier

March 20, 1931—Subject and speaker to be announced later.

April 17, 1931—Art of Engineering, by Mr. Dohner, Westinghouse Electric & Mfg. Co.

Seattle

March 17, 1931—Annual joint meeting of the Founders' Societies with program in charge of the American Society of Civil Engineers.

April 21, 1931—Annual joint meeting with the A. I. E. E. Student Branch of the University of Washington. Program under the auspices of the students.

Sharon

March 3, 1931—Recent Interesting Aeronautical Developments, by Lieutenant S. P. Mills, War Department, Wright Field, Dayton, Ohio.

Spokane

March 27, 1931—Program by local members as follows: Service and Services, by G. S. Covey; Standard Meter Equipment, by J. G. Finley; Relay Applications to Feeder Protection, by C. F. Norberg.

Toledo

March 20, 1931—Industrial Applications of Vacuum Tubes and Photoelectric Cells, by E. L. Manning, General Electric Laboratories, Schenectady, N. Y.

Past Section Meetings

Akron

Excitation Systems and Excitation Problems, by James F. Foote, Allied Engineers, Inc. January 8. Attendance 115.

Atlanta

The Responsibilities of the Engineers, by R. V. Wright, managing editor, *Railway Age*, and president, A. S. M. E. W. L. Stanley, Seaboard Air Line Railway, described the important problems of railroads. Joint meeting with the A. S. M. E. and A. S. C. E., preceded by dinner. February 3. Attendance 85.

Boston

Possible Application of High Tension D. C. Transmission, by H. R. Summerhayes, General Electric Co. Mr. Mr. Summerhayes outlined the development work his company is doing on thyratron tubes, and explained by the use of slides the action within the tubes and how they would be used on a transmission line. January 13. Attendance 300.

Cincinnati

George W. Bason, Condit Electrical Mfg. Corp., presented a talk on the various factors involved in circuit breaker operation. Illustrated with slides and motion pictures showing actual arc interruptions made under oil in heavy glass tanks. Dinner preceded the meeting. December 11. Attendance 102.

Cleveland

Future Power Development and Distribution in the Cleveland Metropolitan Area, by H. L. Wallau, Cleveland Electric Illuminating Co. Having described the generating equipment used by the above Company in 1901, Mr. Wallau outlined and illustrated the development and progress of the system from that period to the present day. January 22. Attendance 115.

Columbus

Some New and Interesting Developments in Engineering and Research by C. K. Lee, Westinghouse Electric & Mfg. Co. Illustrated. Also, moving pictures showing modern mechanized mining. January 31. Attendance 60.

Connecticut

Machine Switching Mechanism, by O. C. Levy, Automatic Electric, Inc. Illustrated with slides and a demonstration of the Strowger automatic telephone. Meeting held at Dunham Laboratory, Yale University. January 16. Attendance 98.

Denver

General Aspects of the Boulder Canyon Project, by E. B. Debler, U. S. Reclamation Bureau. Illustrated with lantern slides. January 16. Attendance 56.

Erie

History and Art of Paper Making, by Henry J. Obermans, Hammermill Paper Company. Many exhibits on display. December 16. Attendance 118.

Fog Flying and Development of Electrical and Magnetic Instruments for Blind Flying, by E. G. Haven, General Electric Co. Dinner in honor of the speaker preceded the meeting. January 20. Attendance 118.

Fort Wayne

Dance. January 23. Attendance 80.

Indianapolis-Lafayette

The Production of Copper, by E. S. McConnell, Anaconda Wire & Cable Co. Moving pictures showing the production of copper, starting at the mine and carrying through the various stages to the finished wire, tube, and sheet, were presented. Dinner preceded the meeting. January 23. Attendance 42.

Ithaca

Some Engineering Considerations of Talking Movie Apparatus, by Herbert Belar, R. C. A.-Victor Co. The underlying principles of sound picture systems and functions of each component part were explained in detail. January 23. Attendance 150.

Kansas City

The Engineers Place in the Community, by Rev. Earle A. Blackman, Sponsor, Kansas City Youths' Forum;

Specialty, by B. J. George, Kansas City Power & Light Co. December 23. Attendance 51.

Some Recent Developments in Lightning Protection, by I. P. Monseth, Westinghouse Electric & Mfg. Co.;

Futuristic Trend in Switchgear Equipment, by A. J. Peterson, Westinghouse Electric & Mfg. Co. Illustrated. January 28. Attendance 76.

Los Angeles

The Small but Mighty, by Dr. H. D. Arnold, Bell Telephone Laboratories, Inc. Considerable discussion followed. January 27. Attendance 271.

Madison

Symposium on Methods of Increasing the Load Factor of a Power Distribution System. Speakers—S. M. Coe, Wisconsin Power & Light Co. and Harold E. Koch, Hevi Duty Electric Co. Discussion followed. January 21. Attendance 43.

Memphis

The New City Water Works Plant, by Major Thomas H. Allen, consulting engineer. Discussion followed. January 13. Attendance 24.

Mexico

The Exploitation of Saltpeter in Chile, by E. F. Lopez, National Import Co.;

Car Lighting by Electricity in the National Railways of Mexico, by R. C. Rodriguez, National Railways of Mexico. Illustrated with charts. January 13. Attendance 41.

The Applications of Electricity in Sugar Mills, by E. I. Brown; Mental Calculations, by E. Leonarz, Jr., Mexican Light & Power Co. February 3. Attendance 34.

Milwaukee

A New System of Speed Control for A. C. Motors as Applied to Auxiliary Power Stations, by Fraser Jeffrey, Allis-

Chalmers Mfg. Co. Illustrated with slides. Discussion followed the talk. January 7. Attendance 205.

ARC WELDING GENERATORS AND THEIR APPLICATION, by K. L. Hansen, Northwestern Mfg. Co. Mr. Hansen traced the history, application of arc welding, necessary apparatus, and latest developments in the art. Discussion followed. February 4. Attendance 53.

Minnesota

ANALYSIS OF CIRCUIT BREAKERS UNDER SHORT CIRCUIT, by George W. Swallow, American Brown Boveri Co., Inc. Illustrated with motion pictures. January 28. Attendance 150.

Nebraska

THE DEVELOPMENT AND APPLICATION OF RADIANT ENERGY, by T. Tennyson Harris. January 19. Attendance 25.

OIL CIRCUIT BREAKER PHENOMENA, by George W. Swallow, American Brown Boveri Co., Inc. February 4. Attendance 50.

Niagara Frontier

APPLICATION OF ELECTRIC POWER IN RAILROAD TRANSPORTATION, by S. T. Dodd, General Electric Co. Illustrated with slides and motion pictures. Informal dinner in honor of the speaker was held at the Hotel Statler. January 16. Attendance 60.

Philadelphia

Smoker at the Penn Athletic Club. February 9. Attendance 200.

Pittsburgh

SOME RECENT WORK OF THE BUREAU OF STANDARDS, by Dr. G. K. Burgess, Director, Bureau of Standards. Moving pictures and a demonstration of the theremin followed. Midwinter dinner meeting held jointly with the Engineers Society of Western Pennsylvania. January 13. Attendance 277.

Pittsfield

YUCATAN AND ITS ANCIENT CIVILIZATION, by Colonel E. H. Thompson. Illustrated with lantern slides. January 13. Attendance 850.

ELECTROTHERAPEUTICS, by Dr. William Bierman, New York Physical Therapy Society. Illustrated. January 26. Attendance 175.

WITH BYRD TO THE BOTTOM OF THE WORLD, by Dr. Laurence Gould, University of Michigan. Illustrated with moving pictures. February 3. Attendance 990.

Portland

BUILDING OF CONDIT—YAKIMA 110 KV. LINE, by C. S. Knowles, Pacific Power & Light Co.;

NEW DEVELOPMENTS IN HIGH SPEED OIL CIRCUIT BREAKERS AND RELAYS, by E. C. Curtis, General Electric Co. December 16. Attendance 80.

THE SMALL BUT MIGHTY, by Dr. H. D. Arnold, Bell Telephone Laboratories, Inc. Dinner in honor of the speaker preceded the meeting. January 15. Attendance 220.

Providence

AIMS AND OBJECTS OF THE INSTITUTE, by Professor Harold B. Smith, Worcester Polytechnic Institute. Dinner preceded the meeting. December 9. Attendance 40.

THE ELECTRICAL DEVELOPMENT OF THE FIFTEEN MILE FALLS HYDROELECTRIC PROJECT, by E. W. Dillard, New England Power Association. Illustrated with lantern slides and motion pictures. Dinner in honor of the speaker preceded the meeting. January 7. Attendance 150.

St. Louis

RADIO SYSTEM OF THE ST. LOUIS POLICE DEPARTMENT, by Professor R. S. Glasgow, Washington University. E. J. Bonnesen, Bell Telephone Laboratories, Inc., gave an interesting account of the new broadcast station KMOX. January 21. Attendance 180.

San Antonio

AIR CONDITIONING OF A MODERN OFFICE BUILDING, by T. M. Cunningham, Carrier Engineering Corp. Following the address, those present inspected the air conditioning apparatus in the Milam Building. January 26. Attendance 35.

San Francisco

THE SMALL BUT MIGHTY, by Dr. H. D. Arnold, Bell Telephone Laboratories, Inc. Illustrated. Dinner preceding the meeting held at the Engineers' Club. January 23. Attendance 450.

Seattle

THE SMALL BUT MIGHTY, by Dr. H. D. Arnold, Bell Telephone Laboratories, Inc. January 19. Attendance 130.

Sharon

AUDIBLE LIGHT, by John B. Taylor, General Electric Co. Demonstrations of applications of the photoelectric cell. February 3. Attendance 320.

Spokane

THE SMALL BUT MIGHTY, by Dr. H. D. Arnold, Bell Telephone Laboratories, Inc. January 12. Attendance 200.

Syracuse

AIDS TO AERIAL NAVIGATION, by Charles F. Green, General Electric Co. November 17. Attendance 167.

RADIATION ENERGY—SUN AND ARTIFICIAL RAYS, by Paul Luckenbach, General Electric Co. January 12. Attendance 249.

Toledo

POWER TRANSMISSION AND HIGH-VOLTAGE INSULATORS, by A. O. Austin, Ohio Brass Co.;

REGULATION ON DISTRIBUTION SYSTEMS, by W. T. Lowery, Toledo Edison Co. Illustrated. January 16. Attendance 90.

Toronto

ARTIFICIAL TRANSIENTS OF TRANSMISSION LINES WITH PARTICULAR REFERENCE TO PERFORMANCE OF LIGHTNING ARRESTERS, by K. B. McEachron, General Electric Co. Illustrated with slides. January 23. Attendance 110.

Urbana

PHYSICAL PROPERTIES AND PROBLEMS OF DIELECTRICS, by Professor V. Karapetoff, Cornell University, and Professor J. Kunz, University of Illinois. January 13. Attendance 175.

Utah

RESEARCH DEVELOPMENTS, by H. T. Plumb, General Electric Co. Apparatus for demonstration purposes on display. January 19. Attendance 84.

Vancouver

PRACTICAL ASPECTS OF SYSTEM STABILITY, by F. A. Hamilton, Jr., General Electric Co. Discussion followed. February 2. Attendance 51.

Washington

INDUSTRIAL APPLICATIONS OF VACUUM TUBES, by E. L. Manning, General Electric Co. Mr. Manning described early and recent developments of vacuum tubes and discussed present and possible future industrial applications. Dinner in honor of the speaker held at the Cosmos Club. January 13. Attendance 249.

CABLES FOR THE TRANSMISSION OF POWER, by I. T. Faucett, General Cable Corp. Illustrated with slides and moving pictures. Dinner preceded the meeting. February 10. Attendance 97.

Past Branch Meetings

University of Akron

THEORY AND APPLICATION OF DIVERTER POLE GENERATORS, by N. Dickinson, Student;

AMATEUR RADIO, by S. Liebowitz, Student. Accompanied by a demonstration of a short-wave code transmitting set. January 14. Attendance 14.

Alabama Polytechnic Institute

Oil Electric Locomotives, by K. R. Clark, Westinghouse Electric & Mfg. Co. January 8. Attendance 8.

Discussion of means to increase student participation at meetings. January 29. Attendance 7.

General discussion of Branch activities. February 5. Attendance 12.

University of Arkansas

Television, by Hugh Nelson, Student. Film—"A Tell You How Story of Telephotography." February 3. Attendance 30.

Armour Institute of Technology

Lightning Investigation on Transmission Lines, by William Drigot, Student. January 12. Attendance 38.

Illumination, by O. P. Cleaver, Westinghouse Lamp Co. Illustrated with slides. January 26. Attendance 64.

University of British Columbia

Automatic Sulphur Dioxide Testing, by M. Saunders, Student;

The Development of the Incandescent Lamp, by D. Smith, Student. Discussion followed. December 6. Attendance 10.

Inspection trip to the Haro Street substation of the B. C. Electric Railway Co. January 10. Attendance 14.

Electrical Precipitation, by E. M. Kershaw, Branch Secretary;

The Life of Michael Faraday, by E. H. Full, Student. January 20. Attendance 12.

Bucknell University

Prospective Relation of the Hoover Dam to Electrical Power, by L. H. Spangler, Student;

Faraday and His Work, by O. R. Sterling, Branch chrirman. January 19. Attendance 10.

California Institute of Technology

The Electrical Distribution System of Pasadena, by E. L. Bettanier, Pasadena Municipal Light and Power Bureau. Luncheon preceded the talk. January 23. Attendance 40.

University of California

After a discussion of Branch activities three films were presented as follows: "The Manufacture of X-ray Tubes," "Bituminous Coal," and "The Manufacture of Salt." Joint meeting with the A. S. M. E. Branch. January 28. Attendance 81.

Case School of Applied Science

Dinner meeting at which G. A. Sanow, Branch chairman, outlined the activities at the Institute's district meeting held in Philadelphia; F. A. Green spoke about the advantages of membership; and William Thomas, Instructor, discussed his experiences while employed by the General Electric Company in the Testing Department. January 8. Attendance 30.

University of Cincinnati

Michael Faraday, by Carl Heyel, Student;

Recent Trends and Developments in Power-Plant Practises, by D. Brown, Union Gas & Electric Co. Refreshments served after the meeting. February 4. Attendance 27.

Clarkson College of Technology

The Field of Chemical Engineering in Electrical Engineering, by Professor Hecker. Refreshments served. January 13. Attendance 26.

Colorado Agricultural College

Photoelectric Cell, by W. R. Carmack, Student;

Analysis of Electric Heat Treating, by L. Dougherty, Student; A. C. Holden, Student, related his experiences while employed by the Crocker-Wheeler Electric Manufacturing Co. at Ampere, N. J. January 12. Attendance 16.

University of Colorado

Talks on the Hoover Dam Project in the Colorado River Canyon, by E. B. Debler, hydrographic engineer; B. W. Steele, engineer in charge of the dam design; and L. N. McClellan, chief electrical engineer of the power plant. Meeting sponsored by the Bureau of Reclamation, U. S. Department of the Interior. Joint meeting of all engineering societies. January 7. Attendance 208.

Appraisals, by Juston H. Haynes, Lloyd-Thomas Co. January 21. Attendance 28.

Life of Faraday, by J. E. Gorochow, Student;

Life of Joseph Henry, by William Wildhack, Student;

The Thyratron, by Paul Huber, Student. Film—"Through the Oil Lands of Europe and Africa." Refreshments served. February 4. Attendance 60.

Cooper Union

Fuses, Their History, Construction, and Causes of Failure, by L. E. Edwards, Bussman Mfg. Co. January 14. Attendance 60.

Drexel Institute

Television, by E. K. Cliver, Branch Chairman. January 13. Attendance 26.

University of Florida

Operation of the Automatic Telephone, by J. L. Sanders, Student;

Electrical Equipment for Overhead Cranes, by E. Menendez, Student. February 9. Attendance 26.

Iowa State College

Business meeting. January 20. Attendance 42.

Discussion and adoption of By-laws. January 27. Attendance 21.

Televox and Electric Eye, by H. B. Stevens, Westinghouse Elec. & Mfg. Co. Joint banquet with the Iowa Section. February 6. Attendance 410.

University of Iowa

Film—"The Single Ridge." January 21. Attendance 36.

Electric Elevators, by Mr. Hathaway, Student. February 4. Attendance 46.

Kansas State College

Film—"Frozen Credits." Nomination of officers for second semester. January 15. Attendance 106.

Restoration from an Electric Shock, by L. L. Naus, U. S. Bureau of Mines. Election of officers. December 13. Attendance 69.

Lewis Institute

Business meeting. January 13. Attendance 22.

Massachusetts Institute of Technology

Inspection trip to the Edgar generating station of the Edison Electric Illuminating Co. of Boston. January 14. Attendance 40.

Michigan College of Mining and Technology

Experiences with the General Electric Company, by Mr. Howell, Instructor. Motion pictures were shown on the uses of compressed air in industry. January 14. Attendance 21.

Transformers, Their Use, and Methods of Construction, by A. G. Rogers, Student;

Substations, by W. D. Stewart, Student. January 28. Attendance 18.

Michigan State College

Short talk by Professor W. A. Murray, Counselor, on the advantages of membership in the Institute. January 8. Attendance 30.

Business meeting. January 13. Attendance 18.

Discussion of plans for the electrical show. January 27. Attendance 18.

Business discussion. February 10. Attendance 17.

University of Michigan

Power System Development, by S. M. Dean, Detroit Edison Co. January 14. Attendance 65.

School of Engineering of Milwaukee

Audio-Amplification in Public Address Systems and Broadcast Studios, by N. J. Richard, Student. Film—"Blasting the Water Highways of America." A review of business conditions of the past year was outlined by Karl Werwath, Student. January 14. Attendance 85.

University of Minnesota

Inspection trip through the Northern States Power Company's High Bridge Plant in St. Paul. December 3. Attendance 75.

Taxation as a Measure of Valuation of a Public Utility for the Purpose of Establishing a Rate Base, by John Roe, Student;

Sale Price as a Measure of Valuation of a Public Utility for the Purpose of Establishing a Rate Base, by L. A. Rovelsky, Student. January 13. Attendance 52.

Mississippi A. & M. College

Film—"Hydroelectric Production in the New South." January 30. Attendance 61.

Missouri School of Mines and Metallurgy

Biography of Faraday, by G. L. Leisher, Student;

My Summer's Work, by M. R. James, Student. Film—"Steinmetz." January 28. Attendance 16.

University of Missouri

The Engineering Profession and the Rewards it Offers, by A. C. Lanier, head, Dept. of Elec. Eng. February 4. Attendance 28.

Montana State College

The Button Railroad, taken from *Westinghouse Magazine*, presented by M. J. Ovens, Student;

Some Technical Aspects of Sound Picture Photography, taken from Bell Laboratories Record, presented by Joseph J. Schuler, Student;

Power for Aircraft Radio, taken from *Electric Journal*, presented by M. Severud, Student. January 8. Attendance 130.

Three films presented entitled "Building New York's Newest Subway," "Hydroelectric Power Production in the New South," and "Blasting the Waterways of America." January 15. Attendance 213.

Radio Charts the Air Course, taken from *Radio News*, presented by E. J. Christiansen, Student;

Power Generation at Niagara Falls, taken from *Electric Journal*, presented by Earl Doney, Student;

Noise Measurements, taken from Electrical Engineering, presented by Frank Holly, Student;

Improving Theater Acoustics, by Joseph Hurst, Student. January 22. Attendance 131.

English for Engineers, by Paul O. Koetitz, Student;

Piezoelectric Effects, by William McKay, Student;

Vacuum Tubes Lead the Way, taken from Electrical Engineering, presented by Thomas Micka, Student. January 29. Attendance 135.

Industrial Mobilization, by Dr. Kirk, professor of chemistry. Illustrated with lantern slides. February 5. Attendance 149.

University of Nebraska

Election of officers as follows: P. Ehrenhard, chairman; W. G. Norris, vice-chairman; Walter M. Ely, secretary-treasurer. Following dinner, the students went to the Burlington Yards where Mr. Wesson, signal engineer for the C. B. & Q. Railroad, demonstrated the switching and signal system installed there. January 23. Attendance 32.

University of Nevada

Business meeting. January 7. Attendance 8.

Up-River Storage, by James Shaver, Sierra Pacific Power Co. January 14. Attendance 15.

The Operation of the Dial Telephone, by Willis Pressel, Bell Telephone Co. and senior student in Electrical Engineering. January 21. Attendance 16.

Newark College of Engineering

The Mechanical Brain, by C. H. Stephan, Student;

The Application of A. C. Rectifiers to Radio High Voltage Supplies, by A. Katz, Student. January 26. Attendance 18.

The Mercury Jet Wave Rectifier, by G. Rust, Student;

The A-C. Arc and Deion Circuit Breaker, by J. Scheid, Student;

The Earth Inductor Compass, by by C. Wayer, Student. February 9. Attendance 17.

College of the City of New York

Election of officers as follows: Charles Hachemeister, Chairman; Alex Rosenberg, vice-chairman; Howard Klein, secretary; Bernard Beaman, treasurer. January 15. Attendance 20.

New York University

Description of Apparatus and Routine in the Sherman Creek Power Plant, by J. F. Seivers, Student;

Operation of D-C. Relays, by W. J. Driver, Student;

An Acoustical Treatment of Broadcasting Studios, by M. Bogstahl, Branch Secretary;

An Original Idea in Television Scanning, by S. H. Revitz, Student;

Cables, by O. M. Lerz, Student. January 9. Attendance 17.

Business meeting. February 2. Attendance 18.

North Carolina State College

Film—"Nature's Frozen Assets." January 20. Attendance 40.

University of North Carolina

The Principle of the Three-Electrode Vacuum Tube, by Professor R. F. Stainback. Report of the Southern District Meeting at Louisville, by C. P. Hayes, Branch Representative. January 15. Attendance 33.

The Place of the Electrical Engineer in a Power Company, by P. G. Johnson, Student;

Cooperative Talk, by E. F. Frisby, Student. January 29. Attendance 29.

North Dakota State College

Film—"Conowingo." January 16. Attendance 75.

The Centennial Exposition of 1876, by F. W. Pearson, New York Life Insurance Co. Film—"Enamelware." January 28. Attendance 89.

University of North Dakota

The Effect of Lightning on Transmission Lines, by B. J. Shields, Student. Refreshments served. January 14. Attendance 20.

Election of officers as follows: B. J. Shields, chairman; Charles King, vice-chairman; Mark Scarff, secretary-treasurer. Febuary 4. Attendance 20.

Northeastern University

Construction Problems of the Fifteen-Mile Falls Development Transmission Line, by C. A. Booker, New England Power Co. Illustrated with slides. January 13. Attendance 48.

University of Notre Dame

Street Lighting and the Use of Remote Control, by Mr. Guin, South Bend Controllers Co.;

The Photoelectric Cell, by A. Petrauskas, Student;

Crosstalk and Its Elimination in Telephony, by John Perone, Student;

The Life of Ampere, by A. D. Neal, Student. Summary of news events in the electrical field was given by Patrick Murray, Student. January 12. Attendance 66.

Ohio Northern University

Automatic Train Control, by G. F. Ross, Student. January 20. Attendance 15.

Ohio State University

Synchronization of Paper Machinery, by G. E. Stoltz, Westinghouse Electric & Mfg. Company. January 15. Attendance 32.

Ohio University

A New Light-Intensity Meter, by George Wyckoff, Student;

Artificial Fever and Other Effects in the Human Body, by Herbert Adcock, Student. Film—"Arc Welding Industry." January 12. Attendance 14.

Oklahoma A. & M. College

Watt-Hour Meters, by Harold Brown, Student. January 15. Attendance 26.

University of Oklahoma

The Belle Isle Generating Station of the O. G. & E. Co., by Mr. Danner, engineer for the company. Illustrated with diagrams and slides. November 20. Attendance 51.

The Effect of Frequency Cut-Off on Sound Transmission, by Mr. Jones, Bell Telephone Co. Illustrated. January 6. Attendance 44.

Oregon State College

Business meeting. December 19. Attendance 30.

My Experiences at the Solar Observatory and Elsewhere During the Past Year, by Professor W. Weniger. January 15. Attendance 31.

Electromagnetic Light Valve and Its Application to Sound Recording, by Dale Hansen, Student;

High-Permeability Alloys, by C. Boucher, Student. February 2. Attendance 49.

University of Pittsburgh

Radio Compass, by C. W. Robinson, Student. C. H. Carroll, Student, gave a travelogue of a trip from Pittsburgh to New Orleans. December 4. Attendance 118.

A Travelogue Through China and Korea, by S. R. Staples, Westinghouse Elec. & Mfg. Co. Entertainment and refreshments followed. December 11. Attendance 76.

The History of Lighting, by D. C. Stengel, Student. E. F. Freundt, Carnegie Steel Co., reviewed power plant operation at the Homestead Steel Mill. December 18. Attendance 119.

History of the Inhabitants of Czechoslovakia, by M. Getting, Student;

Mine Laying During the World War, by O. L. Endler, Student. January 8. Attendance 111.

Two films as follows: "The Deion Breaker," and "Dynamic America." R. J. Hanna, Westinghouse Research Laboratories, demonstrated a talking motion picture projector. January 15. Attendance 85.

Modern Street Cars, by R. L. Dumeyer, Student. An explanation of the telephone typewriter was given by R. E. Morrell, Student. January 23. Attendance 114.

Pratt Institute

A discussion of the relation between education and industry was given by H. P. Miller, Instructor in Electrical Engineering. January 15. Attendance 91.

Two films presented, "New York's Newest Subway," and "Distribution of Power in the New South." January 29. Attendance 51.

Rhode Island State College

Fifteen-Mile Falls Development, by A. Galonio and J. Scussel, Students. January 19. Attendance 8.

Circuit Breakers, by L. Crandall, Student. Short business meeting followed. February 11. Attendance 13.

Rutgers University

Tendencies and Progress of Railroad Electrification in Europe Compared with American Practise, by Mr. Gelhaus, Student

The Opportunities for Employment with the Railroads, by Mr. Jobbins, Student. December 9. Attendance 20.

Steam Generation, by Mr. Howell, Student;

Transmission and Distribution, by Mr. Trompen, Student;

The Opportunities for Employment with the Electric Light and Power Companies, by Mr. Wegel, Student. January 6. Attendance 21.

University of South Carolina

Radio Central, Rocky Point, L. I., by J. A. Kaigler, Student;

Electric Power for Cotton Mills, by H. G. Smith, Student January 12. Attendance 30.

Election of officers as follows: L. E. Rankin, chairman; C. H. Bryan, vice-chairman, L. W. Dickerson, Jr., secretary. February 9. Attendance 10.

South Dakota State School of Mines

Mr. Mitenger gave an interesting talk on his work with the Westinghouse Electric & Mfg. Co. January 22. Attendance 44.

University of Southern California

Nomination of officers. January 7. Attendance 44.

Election of officers as follows: A. E. Mathews, chairman; H. G. Cook, vice-chairman; M. C. Marshall, secretary; C. M. Drury, treasurer. January 14. Attendance 32.

A discussion of radio interference was given by A. G. Walters, Radio Trades Commission. January 21. Attendance 26.

Stanford University

Panel Type and Step-by-Step Type of Dial Telephone Systems, by W. W. Stahl, Pacific Telephone & Telegraph Co. January 15. Attendance 31.

Inspection trip through the Palo Alto exchange of the Pacific Telephone & Telegraph Co. January 17. Attendance 23.

Syracuse University

Thyratron Tubes, by Donald Robinson, Student;

Electrical Equipment in the Gypsum Industry, by Willis Kleppinger, Student. February 6. Attendance 25.

University of Tennessee

Engineering Salesmanship, by J. E. Housley, Aluminum Company of America. February 5. Attendance 18.

University of Texas

Election of officers as follows: T. E. Cole, President; C. J. Pilgrim, vice-president; J. H. Neidert, secretary-treasurer; D. Sussin, corresponding secretary. January 23. Attendance 49.

University of Vermont

Micarta Insulation, by E. V. Kibby, Student. January 13. Attendance 25.

Film—"Through the Switchboard." February 10. Attendance 33.

Virginia Polytechnic Institute

The Steinmetz that I Knew, by J. E. Birdsall, Student;

The Signal Corps Camp, by L. W. Webb, Jr., Student;

Arc Welding and Structural Steel, and, A Soundless Substation, by F. S. Boch. January 15. Attendance 31.

Business discussion. January 29. Attendance 22.

University of Virginia

G. G. Quarles, branch chairman, gave a report of the conference on Student Activities held during the Institute's Southern District meeting at Louisville, Ky. January 13. Attendance 16.

University of Washington

Film—"From Mine to Consumer." December 11. Attendance 23.

My Trip East to the Tau Beta Pi Convention, by George Palo, Student. January 8. Attendance 18.

A Year in the Frozen Arctic, by Robert J. Gleason, Student. January 15. Attendance 14.

Washington State College

Crysal Oscillators, by Lester Hatfield, Student. Duane Olney, Student, described the hydroelectric station on the Clearwater River, owned by the Pacific Power & Light Co. January 7. Attendance 24.

Washington University

L. W. Sieck, Student, gave a talk on the

St. Louis, Mo., police radio installation. January 15. Attendance 18.

West Virginia University

Business meeting. February 3. Attendance 30.

University of Wyoming

Einstein's Theory of Relativity, by Dr. Philo F. Hammond, head of Physics Department. January 22. Attendance 37.

Yale University

Tide Water Power, by H. Gears, Student;

Rocky River Development of the Connecticut Light and Power Company, by A. A. Watson, Student;

Boulder Canyon Project, by O. C. Rutledge, Student. December 9. Attendance 13.

Electro-Acoustic Reproduction of Sound, by Dr. E. E. Free, Professor of General Science, N. Y. University. Joint meeting with the A. S. M. E. Branch. January 6. Attendance 66.

The Art of Public Speaking, by Professor Hubert Greaves. Illustrated. January 13. Attendance 44.

Strowger Dial System, by E. Levy, Automatic Electric Company. Joint meeting with the Connecticut Section, A. I. E. E. January 16. Attendance 97.

Lightning Arrester Problems in Distribution Systems, by R. Philip Hart, Cazenovia Electric & Telephone Co. January 17. Attendance 30.

A Comprehensive Study of Electrical Developments in 1930, by J. N. Buckwalter, Student;

A Statistical Survey of Electrical Industries in 1930, by L. Clare, Student;

The National Broadcasting Network, by P. Thomson, Student;

Steel Mills, by R. M. Ferris, Student;

Direct Current Application to Steel Mill Drives, by D. B. Fisk, Student;

Alternating Current for Steel Mill Drives, by R. Schlitt, Student. January 20. Attendance 13.

Employment Notes

Of the Engineering Societies Employment Service

Men Available

ELECTRICAL ENGINEER, age 28; single; with considerable industrial experience; one year as graduate assistant; M. S., Iowa State College, 1930; B. S., Pennsylvania State College, 1925. Desires position as instructor, with prospect of permanent teaching position. C-3202.

ERECTING ENGINEER, 46, of broad experience in power plant construction, maintenance and operation. Exceptional ability in the erection and wiring of switchboards, power plant auxiliaries, oil circuit breakers, and high-voltage outdoor substations. Available immediately. C-8792.

HEAD OF ENGINEERING DRAWING DEPARTMENT of prominent university for seven years will consider change to similar position. Available June 1931. B. S. in electrical engineering. Telephone and electrical experience. Practical machine designer. B-8248.

1930 GRADUATE ELECTRICAL ENGINEER, University of Minnesota, age 23. Experience as a regular tester at Westinghouse Electric & Manufacturing Company. Desires position with a power company. Interested in generator or distribution work. Location, Middle West or Pacific Coast. Available now. C-8796.

ELECTRICIAN, experienced in all branches of electrical work, especially insulation application and manufacture. Capable of directing any type of electrical construction or maintenance. Considerable experience in development and application of porcelain parts. C-8769.

MECHANICAL AND ELECTRICAL ENGINEER, after thirteen years with one of the leading corporations, is now available. Experience covers all phases of design, construction, and operation of modern turbo-electric generating stations for public and private utilities, including putting existing plants in more efficient operation at moderate cost. C-8249.

GRADUATE ELECTRICAL ENGINEER, 1921. Many years' maintenance and construction work in Latin America, design and drafting experience, sound sales engineering training with G. E., fluent Spanish. Desires position along commercial or engineering lines. Preferred location, New York City or abroad. Available immediately. C-6551.

ELECTRICAL-MECHANICAL ENGINEER, married, 7 years' experience including G. E. Test, substation and distribution with utility, development with electrical manufacturer, superintendent of small shop and operation of substations and motor rooms with a steel mill. C-1068.

ELECTRICAL ENGINEER, 1930, experienced in installation, maintenance, and repair of motors as used in plants for driving industrial machinery. Have had some work on control; control of equipment for motors, on a-c. and d-c. circuits. Desires to connect with some kind of industrial equipment company. Location, immaterial. C-8763.

GRADUATE ELECTRICAL ENGINEER, 1929. One year Westinghouse Student Course. Several months' diagram and substation layout experience. Age 23, single. Location preferred, Middle West. C-8523.

ELECTRICAL ENGINEER, 1930 graduate of first-class technical school of New York State desires immediate connection. Prefers testing, research, or any other junior electrical engineering work suitable for a recent graduate. Some hydroelectric, power and lighting maintenance, construction, installation and testing before graduation. Keeping up in studies. Not interested in sales. Good references and personality. C-7936.

ELECTRICAL ENGINEER, 30, single, technical graduate, G. E. Test, ten years design and construction of substation, power plants, electrical railways and mines, five years foreign. Desires position as engineer or general foreman. Location, anywhere. Available at once. C-217.

SOUTH AMERICAN ELECTRICAL ENGINEER, 1930 graduate, 25, single. Two and one-half years' power plant experience. Desires connection with an American company. Location in any part of the States or in any Spanish speaking country. C-8766.

GRADUATE ELECTRICAL ENGINEER, 1928, single, age 25. Aggregate of two years in public utility and railway operating companies. Year Student Course, and two years railway and material handling application engineering with large manufacturer. Desires position with railway, utility, manufacturer or consulting firm. C-8671.

ELECTRICAL ENGINEER, university graduate, 44, married. Two years G. E. Test, 16 years' experience in design and manufacture of transformers with large companies. Desires position with utility or manufacturing company. Best of references. Available on short notice. C-8806.

ELECTRICAL ENGINEER, age 42. Have twenty years' experience in public utility business design, construction and operation. Also some industrial experience. With last employer twenty years. Location, immaterial. C-8798.

ELECTRICAL ENGINEER, college graduate, 31, married. Eleven years in station, transmission and distribution designs; system operation and planning; superintendence of meter and relay department; studies; reports and calculations. Good theoretical as well as practical background. Accustomed to responsibilities. Prefer New York or environs but will consider good proposition elsewhere. B-9401.

ELECTRICAL ENGINEER, graduate Sheffield Scientific School, 23 years' experience including: electrical contracting with companies doing large power work; five years in service department of large electrical manufacturing company as field engineer and supervisor. Experienced electrical estimator. Desires permanent connection, preferably in the East. C-3175.

INDUSTRIAL ENGINEER, electrical graduate, with additional study at M. I. T. Three years' manufacture and electrical test. Considerable electrical and mechanical experience relative to application of power equipment in industrial plants. Fifteen years' experience including seven years with electric utilities. Available upon short notice. Location, anywhere. A-4018.

PHYSICIST Ph. D., 39 years old, with 12 years' experience in electrical development, formerly chief of a physical laboratory, familiar with U. S. A. and foreign patent laws, desires position in electrical concern, preferably television or movietone laboratory. C-8604.

GRADUATE ELECTRICAL ENGINEER, 29, married. Two years' experience on industrial plant layout. 1½ years supervising construction jobs and one year system planning, eastern utility. Desires position where extensive accounting knowledge, acquired through night studies is an asset. Best references. Location preferred, Metropolitan New York. Available immediately. C-8535.

COLLEGE GRADUATE, 25, single, B. S. degree in E. E. Seven months R. C. A engineering course, 11 months N. B. C. engineering course. Experience in development and research work. Seeking position in any electrical line with future and opportunity for advancement. C-8457.

ELECTRICAL ENGINEER, S. B. degree in in E. E. in 1925. Five years' experience in electrical equipment design, public utility operation and field construction. Natural writing talent. Desires work in editorial or related fields. C-4875.

WEST COAST REPRESENTATION—ELECTRICAL ENGINEER with successful selling experience, wishing to locate in Southern California, offers his services to manufacturers of products requiring a representative with engineering background. At present employed in New York City. C-1074.

WIRING DIAGRAM SPECIALIST, desires position with public utility; 43, married, technical education. Understands cooperation necessary between office and field forces in connection with wirings. Familiar with power-house and substation layouts, conduit plans, bus structures, switchboards. Experienced in drafting and its application to field work. Location preferred, East or South. C-8436.

ELECTRICAL DESIGNING ENGINEER, technical graduate, 33, expert draftsman. Power-plant, substation and illumination design experience. Two years' experience on mercury arc rectifier substations for railway service. Seeking permanent position with progressive concern. B-7332.

GRADUATE ELECTRICAL ENGINEER, single, 33. Six years with large manufacturing corporation. Experienced in manual and automatic switchgear application, preparation of specifications, testing and electrical drafting. Location, United States America. Available immediately. C-8680.

GRADUATE ELECTRICAL ENGINEER, 31, single, eight years' experience, design and construction of transmission lines, voltages up to, and including 220-kv., outdoor and indoor high-voltage substation and distribution networks. Desires position in engineering or construction department of large utility or holding company. Location, immaterial. C-3564.

ELECTRICAL DRAFTSMAN, 29, single but with dependents. Experienced on substation and power-house design, industrial and marine equipment installation. Desires temporary or permanent position. Available at at once. Location preferred, Pacific Coast. C-8729-311-C-7.

PRODUCTION MANAGER, age 49, married. Mechanical and electrical graduate. Experienced executive and organizer. Eighteen years' experience in production, maintenance, plant layout, budgeting, estimating and time study in large machinery and copper wire field. Desires a position that requires energy and initiative. Available immediately. Location preferred, immaterial. C-4440.

ELECTRICAL ENGINEER has had 8 years' experience with vacuum tube applications. Experience has covered research and development of precision laboratory apparatus. Recent activities have been centered on audio-frequency transmission circuits and design of high quality amplifiers. Inquiries invited from leading companies requiring such services with location preferably in New York. C-8745.

RAILROAD-TELEPHONE MAN, 42, married. Six years' railroad experience, 25 years' telephone experience. Desires position as foreman. Qualified to engineer layout of circu ts for construction, maintenance, installation of printers, pneumatic tubes, other communication auxiliaries. Able to do Western Union Telegraph contact work, prepare close estimates and handle men. Can furnish references. C-7753.

GRADUATE ELECTRICAL ENGINEER, 28, married, American, wishes position in experimental, research or development work. Three years' experience in inspection and small instruments. Two years in accounting and statistics. B-8815.

ENGINEER, B. S. Harvard; B. S. Massachusetts Institute of Technology, mechanical and electrical engineering. Three years instructor in physics and electrical engineering. Three years drafting and design. Three and one-half years radio research and development, last two and one-half years being with R. C. A. Victor Company (Massachusetts). C-4275.

INDUSTRIAL ELECTRICAL ENGINEER, 43, over 15 years' experience on industrial plants, distribution, special applications; design, specifications, construction and maintenance. Also fire prevention and protection engineering. C-8414.

ELECTRICAL ENGINEER, 35, technical education with 10 years' executive experience supervising both design and construction. Desires position as engineer in charge of design or construction, or plant engineer. Location, immaterial. C-8683.

ELECTRICAL DESIGN DRAFTSMAN OR CHECKER, 31, single. Third year night engineering, twelve years' experience covering design of power plants, substations and network systems. Desires connection with public utility or engineering firm. Location, immaterial. Available on two weeks' notice. B-8628.

GRADUATE ELECTRICAL ENGINEER, age 25, single. Reared in the Orient, traveled widely. One year test course with motor manufacturer, one year sales experience on Pacific Coast. Desires permanent location with a company looking forward to an expansion in its foreign business. Available at once. Location, anywhere in U. S. B-6945-311-C-5-San Francisco.

MANAGER OR SUPERINTENDENT, age 47, married. Executive, electrical or industrial. Successful organizer, efficient operator. Knows men and can handle them. Especially interested properties not now paying, where future depends on results. Reads, writes, and speaks Spanish. Capable earning six thousand up. Available, reasonly short notice. Location, preferred, not particular (Western U. S. preferred). C-8777-312-C-1-San Francisco.

TECHNICAL GRADUATE in electrical engineering, 29, single, 1½ years' G. E. Test; over 10 years' experience with leading electrical company in repair and testing of electrical apparatus. Desires position in testing and experimental work on motors, generators, etc. Future prospects considered more important than initial salary. Best of references. C-8778.

1930 GRADUATE, ELECTRICAL ENGINEERING, 22, single. Seven months Westinghouse test. Desires position in operating or service department of utility company, but will consider work of any kind. References. Location, West or Middle west. Available at once. C-8779.

ELECTRICAL ENGINEER, 25, single. E. E. and Master's degrees. Good mathematician with theoretical and research grounding. General Electric test and general engineering courses. Interested in pure engineering, mathematics and teaching. Best references. Will consider any location. C-8382.

GRADUATE ELECTRICAL ENGINEER, 35, good technical school. Ten years' experience in electrical station construction and design drafting, including considerable mechanical experience. Latest position superintendent of design and construction of transformer substation. Preferring station design and construction with ability would consider engineering industrial plant maintenance or operation. C-8785.

ENGINEER, specially qualified in industrial construction or management in Spanish America. Twenty years' experience, design, construction, management, sales, more than two-thirds in United States. Unusually fluent, correct Spanish. Large acquaintance officials, industry, South America, especially West Coast.

ENGINEERING SOCIETIES EMPLOYMENT SERVICE

57 Post St. San Francisco N. D. Cook, Manager	205 West Wacker Drive Chicago A. K. Krauser, Manager	31 West 39th St. New York W. V. Brown, Manager

MAINTAINED by the national societies of civil, mining, mechanical, and electrical engineers, in cooperation with the Western Society of Engineers, Chicago, and the Engineers' Club of San Francisco. An inquiry addressed to any of the three offices will bring full information concerning the services of this bureau.

Men Available.—Brief announcements will be published without charge; repeated only upon specific request and after one month's interval. Names and records remain on file for three months; renewable upon request. Send announcements direct to Employment Service, 31 West 39th Street, New York, N. Y., to arrive not later than the fifteenth of the month.

Opportunities.—A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

Voluntary Contributions.—Members benefiting through this service are invited to assist in its furtherance by personal contributions made within 30 days after placement on the basis of 1.5 per cent of the first year's salary.

Answers to Announcements.—Address the key number indicated in each case and mail to the New York office, with an extra two-cent stamp enclosed for forwarding.

Would take a contract, branch managership, or sales agency part commission basis, any engineering line, states or abroad. C-8822.

SWITCHBOARD FOREMAN, age 31, married, four years with Western Electric Company. Six years with construction companies for public utilities, specializing in installation of switchboards and control apparatus for power houses and substations. Also experience in metallic telephone and carrier current telephone installation. C-4831.

ELECTRICAL ENGINEER, 27, single. Experience with public utility company in transmission, distribution (overhead and underground), and substation design and construction. Two years design on motor installations and power-plant equipment with nationally known engineering corporation. Desires connection with engineering department of public utility company in West or Middle West. C-8541.

ELECTRICAL ENGINEER, 24, single. B. S. in E. E. Westinghouse graduate student course. Twenty-one months' experience, design and application of railway control apparatus. Also some experience as student engineer, large power company. Desires position with opportunity for advancement with railway operating company, other utility, manufacturing company. Location preferred, East, Middle West. C-8742.

ELECTRICAL ENGINEER, B. S. degree in 1919; age 33, married. Ten years' experience with large company making electrical power apparatus, includes designing of electrical and mechanical construction and calculating of cost, weight and dimensions, in connection with customers' negotiations. Available at once. Location, immaterial. C-4633.

ELECTRICAL ENGINEER, 24, married. Desires engineering work. Has had experience with oscillographs and radio. Holds second-grade commercial wireless operators license. Has public utility test experience. Also surveying experience. Personal interview desired. C-3035.

GRADUATE ELECTRICAL ENGINEER, 30, married. Practical experience in design and construction of industrial equipment and lighting layouts; electric overhead and underground distribution with traction utility; electric and general contracting in own business. Available immediately. B-6384.

GRADUATE ELECTRICAL ENGINEER, 28, four years' manufacturing experience in production and engineering on electrical motors, desires position with company where greater opportunities are offered. C-2882.

Membership

Transfers Recommended

The Board of Examiners, at its meeting of February 18, 1931, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the National Secretary.

To Grade of Fellow

CHURCHWARD, ALEXANDER, Technical Director, Wilson Welder & Metals Co., North Bergen, N. J.
HARRISON, WILLIAM H., plant engineer, American Tel. & Tel. Co., New York.
JOHNSON, F. ELLIS, head of Dept. of Elec. Engg., Iowa State College, Ames, Iowa.
MELVIN, HOWARD L., assistant electrical Engr., Electric Bond & Share Co., New York.
SILLCOX, LEWIS K., vice-president, New York Air Brake Co., Watertown, N. Y.

To Grade of Member

ABBOTT, THOMAS A., instructor in Elec. Engg., Yale University, New Haven, Conn.
AYRES, EDMUND D., Asst. Prof. of Elec. Engg., University of Wisconsin, Madison, Wis.
BRAATEN, THEODORE, Switchgear Engineer, Westinghouse Elec. & Mfg. Co., Boston, Mass.
BROWN, JOSEPH S., engineer, Stone & Webster Engg. Corp., Boston, Mass.
BURTON, JAMES A., telephone & telegraph engr., American Tel. & Tel. Co., New York.
COWGILL, LESTER B., asst. engr., Electric Bond & Share Co., New York.
FARRINGTON, JOHN F., radio engr., International Communications Labs., New York.
HAGAN, JAMES S., elec. engr., Central Railroad Co. of New Jersey, Jersey City Terminal, N. J.
HENDRICKS, CHESTER I., Plant Engr., Texas Electric Service Co., Fort Worth, Texas.
HUTTON, LESLIE B., chief engr., Southland Electric Power Board, Invercargill, N. Z.
JORDON, CHARLES A., asst. engr., Electric Bond & Share Co., New York.
PIERCE, ROBERT E., asst. engr., Electric Bond & Share Co., New York.
SCHWAGER, A. C., oil circuit breaker design engr., Pacific Electric Mfg. Corp., San Francisco, Calif.
SQUIRES, HOWARD A., district manager, Delta-Star Electric Co., and Champion Switch Co., Boston, Mass.
VAN DYCK, WILLIAM VAN BERGEN, manager, International General Electric Co. Inc., Schenectady, N. Y.
WRIGHT, ERNEST M., asst. engr., Pacific Gas & Elec. Co., San Francisco, Calif.

Applications for Election

Applications have been received by the Secretary from the following candidates for election to membership in the Institute. Unless otherwise indicated, the applicant has applied for admission as an Associate. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the Secretary before March 31, 1931.

Abeel, L. B., Tonawanda Power Co., North Tonawanda, N. Y.
Amick, W. M., Western Electric Co., Inc., Newark, N. J.
Anderson, E. G., General Electric Co., Fort Wayne, Ind.
Babbitt, G. W., Canadian & General Finance Co., Toronto, Ont., Can.
Bairos, C. A., Stanford University, Stanford University, Calif.
Barnett, F. G. (Member), Rockford Electric Co., Rockford, Ill.
Becker, A. J., Allis-Chalmers Mfg. Co., Pittsburgh, Pa.
Berlin, J. A. W., International Harvester Co., Chicago, Ill.
Blocksom, F. C., United States Bureau of Mines, Denver, Colo.
Boicourt, F. R., Iowa Public Service Co., Storm Lake, Iowa
Breece, C. A., Indiana Bell Tel. Co., Indianapolis, Ind.
Butler, J. W., General Electric Co., Schenectady, N. Y.
Campbell, G. H., General Electric Co., New York, N. Y.
Clutts, C. E., American Tel. & Tel. Co., New York, N. Y.
Cole, C. S., Copper & Brass Research Association, New York, N. Y.
Compton, K. T., (Fellow), Mass. Inst. of Technology, Cambridge, Mass.
Crary, S. B., Jr., General Electric Co., Schenectady, N. Y.
Cyr, A. J., New Brunswick Electric Power Comm., St. John, N. B., Can.
David, A. R., Brooklyn Edison Co., Brooklyn, N. Y.
Deavers, W. R., Virginia Electric & Power Co., Richmond, Va.
Diaz, M. S., Allis-Chalmers Mfg. Co., West Allis, Wis.
Dorman, B. H., General Electric Co., Buffalo, N. Y.
Elder, T. W., The Ohio Power Co., Coshocton, Ohio
Erskine, S. E., Canadian General Electric Co., Vancouver, B. C., Can.
Fife, W. H., United Electric Light & Power Co., New York, N. Y.
Foos, C. B., General Electric Co., Schenectady, N. Y.
Fountain, L. L., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Franzen, J. E., Management Engg. Corp., Indianapolis, Ind.
Geer, A. L., Shell Pipe Line Corp., Colorado, Tex.
Gosinski, J. N., Allied Engineers, Inc., Jackson, Mich.
Goslin, R. A., Fairbanks-Morse & Co., Indianapolis, Ind.
Haege, O. C., E. J. Cheney, New York, N. Y.
Hamner, F. G., Allied Engineers, Inc., Birmingham, Ala.
Hansen, P., Western Union Telegraph Co., New York, N. Y.
Haynes, H. H., 59 Hilltop Drive, Nichols, Bridgeport, Conn.
Heiser, C. A., Anaconda Wire & Cable Co., Dallas, Tex.
Henderson, F. M., Indiana & Michigan Electric Co., South Bend, Ind.
Herrington, L. B., Kentucky Utilities Co., Louisville, Ky.
Hitchcock, R. C., (Member), Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Hively, J. P. H., General Electric Co., Schenectady, N. Y.
Holper, P. E., Western Electric Co., Kearny, N. J.
Holzman, W. H., 245-29th St., Oakland, Calif.
Horan, T. I., Pennsylvania Power & Light Co., Danville, Pa.

Hutcheson, R. M., Virginia Electric & Power Co., Richmond, Va.
Ikola, G. H., Carnegie Institute of Technology, Pittsburgh, Pa.
Johnson, H. D., General Electric Co., Schenectady, N. Y.
Kilgen, G. J., Jr., New Jersey Public Service Electric & Gas Co., Newark, N. J.
Knaus, W. L., General Electric Co., Schenectady, N. Y.
Koontz, L. F., General Electric Co., Schenectady, N. Y.
Kramer, E. M., Electric Service Supplies Co., Philadelphia, Pa.
Krieger, H. R., Consolidated Gas Electric Light & Power Co., Baltimore, Md.
Kuhn, R. J., (Member), New Orleans Public Service Co., Inc., New Orleans, La.
Leiendecker, J. A., National Lumber & Creosoting Co., Dallas, Tex.
Lilja, E. D., Barber-Colman Co., Rockford, Ill.
Lintern, F. S., Cleveland Railway Co., Cleveland, Ohio
Lloyd, C. I., Western Electric Co., Kearny, N. J.
Lusher, W. R., Hydro-Electric Power Comm. of Ontario, Toronto, Ont., Can.
MacLaren, I. W., University of Kansas, Lawrence, Kans.
Mahr, A., (Member), Central States Pr. & Lt. Corp; Missouri Elec. Pr. Co., Mountain Grove, Mo.
Maibauer, A. E., The Bakelite Corp., Bloomfield, N. J.
Mann, J., Metropolitan Device Corp., Brooklyn, N. Y.
Mason, W. C., General Electric Co., Schenectady, N. Y.
Maynard, S. J., Valley Electric Service Co., Bay City, Mich.
McCanne, L., Stromberg-Carlson Telephone Mfg. Co., Rochester, N. Y.
McClintock, W. E., Allis-Chalmers Mfg. Co., Pittsburgh, Pa.
McConnell, J. D., W. S. Lee Engineering Corp., Charlotte, N. C.
McMillan, R. W., Jr., Pennsylvania Power & Light Co., Allentown, Pa.
McNeil, D. H., Stone & Webster, Inc., Washington, D. C.
McNellis, B., 545 W. 111th St., New York, N. Y.
Meixell, O. S., Western Electric Co., Kearny, N. J.
Mendenhall, V. D., General Electric Co., Philadelphia, Pa.
Mennie, J. H., Western Electric Co., Kearny, N. J.
Merkel, C. O., Edge Moor Iron Co., Edge Moor, Del.
Mirk, D., Moccasin Power House, City of San Francisco, Moccasin, Calif.
Mole, J. R., (Member), Asbestos Corp., Ltd., Thetford Mines, Que., Can.
Moore, F. B., Erie Electric Sales & Service, Inc., Erie, Pa.
Moore, H., Jr., Public Service Co. of Colo., Denver, Colo.
Mowat, G., Pacific Gas & ;Electric Co., San Francisco, Calif.
Nash, E., D. L. & W. Railroad, Hoboken, N. J.
Nudd, P., General Electric Co., Schenectady, N. Y.
Olson, R. C., Cleveland Railway Co., Cleveland, Ohio
Parker, N., Climax Molybdenum Co., Climax, Colo.
Pierson, A. R., Jr., Moloney Electric Co., Atlanta, Ga.
Pollock, M. W., (Member), Cia. Hidroelectrica Guanajuatense, S. A., Mexico, D. F., Mexico
Purrington, T. U., Western Electric Co., Kearny, N. J.
Rainey, M., National Electric Light Association, New York, N. Y.
Raney, W. E., The Colonial Electric Co., Cleveland, Ohio
Rawls, J. A., Virginia Electric & Power Co., Richmond, Va.
Reiter, R., General Electric Co., Schenectady, N. Y.
Ripley, H. C., 18 Virginia St., Milton, Mass.
Runaldue, L. R., General Electric Co., Schenectady, N. Y.
Savage, P. L., General Electric Co., Los Angeles, Calif.
Scampton, W. D., Canadian Utilities Ltd., Nokomis, Sask., Can.
SeLegue, J. B., General Electric Co., Los Angeles, Calif.
Shaw, T. E., Homestake Mining Co., Lead, So Dak.
Shriber, A. L., Dept. of Water & Power, City of Los Angeles, Los Angeles, Calif.
Shuman, M. M. (Member), Virginia Public Service Co., Alexandria, Va.
Small, T. M., Ludlow Manufacturing Associates, Ludlow, Mass.
Smith, H. P., Fairbanks-Morse & Co., Chicago, Ill.
Spatz, W. C., American Tel. & Tel. Co., Richmond, Va.
Specht, W., General Electric Co., Philadelphia, Pa.
Stinson, W. L., (Member), Jeffery Dewitt Insulator Co., New York, N. Y.
Stokes, H. L., University of South Carolina, Columbia, S. C.
Stromsted, A. J., Fuller & McClintock, New York, N. Y.
Stulginskis, B. A., D. P. Robinson & Co., Inc., Trona, Calif.
Sullivan, E. S., The Home Tel. & Tel. Co., Fort Wayne, Ind.
Thomas, M. A., University of Texas, Austin, Tex.
Thuem, C. H., General Electric Co., New York, N. Y.
Titherington, R. G., General Electric Co., Shreveport, La.
Waggoner, E. M., 2 Cannon St., Poughkeepsie, N. Y.
Wang, C. C., 103 E. Oak St., West Lafayette, Indiana
Ware, R. L., Virginia Electric & Power Co., Richmond, Va.
Wasson, O., General Electric Co., Philadelphia, Pa.
Weyerts, E. E., General Electric Co., Tacoma, Wash.
Wilson, J. M., Hydro-Electric Power Comm. of Ontario, Niagara Falls, Ont., Can.
Wolf, H., College of the City of New York, New York, N. Y.
Wong, C. L., 2017 W. Monroe St., Chicago, Ill.
Total 127

Foreign

Ball, R. D., English Electric Co., Ltd., Bradford, Eng.
Bawa, S. K., (Member), Public Works Dept., Lahore, Punjab, India
Cunningham, B. T., Taikoo Sugar Refining Co. Ltd., Hongkong, China
Cutbertson, R. M., L. J. Reynolds, Carrington Chambers, Sydney, N. S. W., Australia
Kemp, R. C., Santa Marta Railway Co., Ltd., Santa Marta, Colombia, South America
Mehta, M. L., Delhi Cloth & General Mills Co., Ltd., Delhi, India
Mistry, K. B., (Member), Public Works Dept., Bombay, India
Sandoval, F., (Member), Chilean State Railways, Santiago, Chile
Shen, P., Chinese Government Radio Administration, Shanghai, China
Tsao, T. C., University of Chekiang, Hangchow, China
Wadadekar, S. V., The Dharwar Electric Supply Co., Ltd., Dharwar, India
Total 11

Engineering Literature

New Books

In the Societies Library

AMONG the new books received at the Engineering Societies Library, New York, during January are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no responsibility for statements made in the following outlines, information for which is taken from the preface or text of the book in question.

INDUSTRIAL HISTORY OF THE UNITED STATES. By Witt Bowden. N. Y., Adelphi Company, 1930. 511 pp., 8 x 6 in., cloth. $4.00.——A very readable one-volume account of our industrial growth from the period of discovery to the present day. The economic forces governing each epoch are clearly indicated and their influence upon our industrial development shown. The general reader as well as the student will find the book of interest.

TELEPHONE THEORY AND PRACTICE, v. 1; Theory and Elements. By Kempster B. Miller. N. Y., McGraw-Hill Book Co., 1930. 486 pp., illus., diagrs., 9 x 6 in., cloth. $5.00.——This is the first volume of a three-volume text which is intended to give students and advanced workers a comprehensive review of modern telephony. The book is the successor of the author's "American Telephone Practice," but is entirely new.

The present volume relates to the underlying theory. An introductory general and historical section is followed by a discussion of acoustical and electrical principles. The elements of telephone apparatus are then treated. The work is non-mathematical and descriptive.

AMBER TO AMPERES; the Story of Electricity. By Ernest Greenwood. N. Y., Harper & Bros., 1931. 332 pp., illus., ports., 10 x 6 in., cloth. $4.00.——Sketches the growth of our knowledge and use of electricity from the earliest times to the present day. The author's method

has been to select the principal events in the progress of the science and to present an account of the social and historical background of each and of the chief personalities involved. The uses of electricity for illumination and communication are emphasized in this interesting work.

Drehstrommotoren mit Doppelkäfiganker und Verwandte Konstruktionen. By Franklin Punga and Otto Raydt. Berlin, Julius Springer, 1931. 165 pp., illus., diagrs., 9 x 6 in., bound. 16.-r. m.——Discusses the design and construction of these motors, explains their advantages and describes the more important commercial types. A section is devoted also to centrifugal couplings.

The Dynamic Universe. By James Mackaye. N. Y., Charles Scribner's Sons, 1931. 308 pp., 8 x 6 in., cloth. $3.50.——This book presents a radiational theory of the structure of matter and the cause of its change of motion. The theory is physical, rather than mathematical or metaphysical. It aims, while accepting Einstein's equations, to give an explanation and reinterpretation of them which will be more natural. An important contribution to theoretical physics.

An Early Experiment in Industrial Organization; being a history of the firm of Boulton & Watt, 1775-1805. By Erich Roll. Lond. & N. Y., Longmans, Green & Co., 1930. 320 pp., plate, 9 x 6 in., cloth. $5.00——An interesting study of the organization of the earliest engineering factory, and of the business methods adopted in its management. The rapid development of the business is traced in detail, and its business organization and policy, wage system, relations with labor, and similar problems are discussed. The point of view is entirely economic.

Electrical Equipment. By T. C. Lloyd. N. Y., John Wiley & Sons, 1930. 287 pp., illus., diagrs., tables, 9 x 6 in., cloth. $3.50.——Intended for students of mining, mechanical and chemical engineering who have studied the theory of the motor, generator, and transformer, and wish a brief account of the theory of a wider variety of electrical equipment, as a guide to the selection of apparatus for given requirements. In addition to the fundamental machines, the author discusses switchboards, meters, storage batteries, illumination, heating, transmission, distribution, and rectification. Comparative cost data are given, and economic questions discussed.

Electroplating; a Survey of Modern Practise. By Samuel Field and A. Dudley Weill. N. Y., Isaac Pitman & Sons, 1930. 205 pp., illus., tables, 8 x 5 in., cloth. $2.00.——A concise treatise which brings together the results of modern research for the practical electroplater.

Guide du Technicien pour l'Organisation du Travail Personnel. By J. Rousset. Paris, Ch. Béranger, 1930. 192 pp., illus., 10 x 6 in., cloth. 62,50 fr.——This unusual book is a guide to the collection and utilization of information, for the benefit of engineers. The author discusses the collection and classification of notes and documents, the organization of libraries, the use of reference libraries, the writing of articles, book publishing and a number of related topics. Much practical, sound advice not collected elsewhere is given.

Magnetic Phenomena. By Samuel Robinson Williams. N. Y., McGraw-Hill Book Co., 1931. (International Series in Physics). 230 pp., illus., diagrs., tables, 9 x 6 in., cloth. $3.00.——A general survey of the whole field, intended to stimulate interest in research work in magnetism and to give the preparatory background for it. The theory of magnetism and the effects of magnetism upon the mechanical, acoustical, electrical, thermal and optical properties of matter are presented.

The Quantam Theory. By Fritz Reiche; translated by H. S. Hatfield and Henry L. Brose. N. Y., E. P. Dutton & Co., 1930. 218 pp., 8 x 5 in., cloth. $2.10.——An excellent account of the origin and development of the quantum theory from its introduction to the present day, which does not make any great mathematical demands upon the reader. A bibliography and numerous references furnish ample guidance to students who wish to pursue the subject further.

Relaisbuch. By Vereinigung der Elektrizitätswerke. Berlin, The Association, 1930. 457 pp., illus., diagrs., plates, 8 x 6 in., cloth. Price not indicated.——A handbook for operators in electric power stations and electrically equipped industrial plants, upon the practical use of protective relays. The protective systems in use, their application under various conditions, the accessories of relay systems, and the methods of testing relays are discussed fully and practically. The book is published by the Association of Electric Plants of Germany.

Richtlinien für Geschweisste Gasrohrleitungen von mehr als 200 mm Durchmesser und mehr als 1 atü Betriebsdruck. Berlin, V. D. I. Verlag 1930. 10 pp., 8 x 6 in., paper. Price not indicated.——Specifications for welding gas mains, approved by the Standards Committee of the Society of German Engineers.

Die Röntgentechnik in der Materialprüfung. By J. Eggert and E. Schiebold. (Ergebnisse der technischen Röntgenkunde, bd. 1). Leipzig, Akademische Verlagsgesellschaft, 1930. 206 pp., illus., diagrs., 9 x 6 in., cloth. 16,80 r. m.——Contains a course of lectures delivered by various specialists at the Charlottenburg Technical High School. These describe the principles of Roentgenology, the apparatus and methods used, and the ways in which X-rays are used to detect flaws in castings and welds, in chemical engineering, and in other branches of manufacturing. Much practical information is given.

Text-Book of Practical Physical Chemistry. By K. Fajans and J. Wüst. N. Y., E. P. Dutton & Co., 1930. 233 pp., illus., 9 x 6 in., cloth. $4.95.——A laboratory textbook, giving detailed directions for performing experiments that illustrate the chief methods of physicochemical investigation. The theory of each experiment is also explained.

Treatise on Physical Chemistry. Edited by Hugh S. Taylor. 2nd edition. N. Y., D. Van Nostrand Company, 1931. 2 v., illus., diagrs., tables, 9 x 6 in., fabrikoid. $15.00 (2 v.).——Intended to present modern physical chemistry with sufficient comprehensiveness to meet the needs of advanced students and of men engaged in industrial research who wish the theoretical treatment of their investigations. The work is the joint effort of a group of eminent authorities and is a most satisfactory treatise.

The new edition has been extensively revised to include recent developments.

Verdampfen Kondensieren und Kühlen. By E. Hausbrand. 7th edition revised by M. Hirsch. Berlin, Julius Springer, 1931. 359 pp., illus., diagrs., 9 x 6 in., cloth. 29.-r. m.——Although issued as a new edition of Hausbrand's well-known work, this is practically a new book. To a larger extent than formerly, the theoretical principles are presented. Formulas and graphs replace many tables of numerical data. The technique of evaporating has been made the principal topic, and condensing and cooling are considered only in relation to evaporating plants.

The new work treats the subject much more systematically and scientifically. The data required by the designer are given extensive discussion, and the construction and use of evaporating apparatus are treated.

Vollständige Zahlentafel und Diagramme für das Spezifische Volumen des Wasserdampfes bei Drücken zwischen 1 und 270 at. By H. Speyerer and G. Sauer. Berlin, V. D. I. Verlag, 1930. 8 pp., 8 x 12 in., paper. 2,50 r. m.——These tables are based on the data of Knoblauch, Raisch, Hausen, Davis and Smith. The tables extend from 100 deg. cent. to 550 deg., by ten-degree intervals. Values are given for each atmosphere below 120, and for each five atmospheres for higher pressures.

Selected Items *From* Engineering Index Service

SELECTED references to current electrical engineering articles from Engineering Index Service's review of some 1,800 technical periodicals are given in the following columns.

All articles indexed are on file in the Engineering Societies Library, New York, which will furnish photoprints of any article at a cost of 25 cents per page or make translations of foreign articles at cost.

Accidents

ELECTRIC. Electric Shock: Interpretation of Field Notes, W. Maclachlan. *Hydro-Electric Power Commission of Ontario—Bul.*, vol. 17, no. 11, Nov. 1930, pp. 418-427, 2 figs. Analysis of reports of approximately 700 cases of electric accidents.

Arcs

ELECTRIC. Some Causes for Variations in the Light and Steadiness of High Intensity Carbons, D. B. Joy and A. C. Downes. *Soc. Motion Picture Engrs.—Jl.*, vol. 16, no. 1, Jan. 1931, pp. 61-65 and (discussion) 65-66, 3 figs. Arc length-arc voltage relations of high intensity arc depend very largely upon relative positions of positive and negative carbons; there is very definite point at which light is maximum and point of maximum light is not point of maximum steadiness. Bibliography.

Busbars

LOSSES. The Efficient Utilization of Conductor Material in Busbar Sections, C. Dannatt and S. W. Redfearn. *World Power (Lond.)*, vol. 14, nos. 83 and 84, Nov. 1930, pp. 397-400 and Dec., pp 492-496, 8 figs. Nov.: Main factors determining conductor losses in a.c. busbar systems and influence of their distribution on temperature rises obtained; extent to which theoretical solutions are available for predetermination of temperature rise. Dec.: Experimental methods for measurement of total loss.

Cables

DESTRUCTION BY INSECTS. Beetle Damage to Lead Cable, E. J. P. Rendell. *Elec. Light and Power*, vol. 8, no. 12, Dec. 1930, pp. 70, 72 and 74, 5 figs. Cases of damage to aerial telephone cables by lead boring insects have been reported from varied parts of world; matters have been investigated by Government scientists whose findings are set forth in bulletin No. 1107 issued by Department of Agriculture; experiments of Pernambuco are related. Abstract of paper in Proc. of Entomological Soc. of Washington.

FUSE BOXES. Network Boxes. *Engineer (Lond.)*, vol. 150, no. 3908, Dec. 5, 1930, p. 622, 1 fig. New type of link or fuse disconnecting box for four or five-core cables put on market by British Insulated Cables, Ltd.; all current-carrying parts are made from high-conductivity copper strip, and number of joints or contacts has been reduced to minimum; links are of plug type, with volted contacts.

GROUNDS. Freak Earth Faults, H. Joseph. *Elec. Times (Lond.)*, vol. 78, no. 2042, Dec. 11, 1930, p. 1019, 3 figs. Analysis of potential differences which even may lead to shock set up in ground near grounded conductor of underground cable.

IMPREGNATING MATERIALS. Weatherproof Impregnated braided Insulation of Electric Lines (Wetterfest getraenkte Beflechtungen von elektrischen Leitungen), E. Kindscher. *Gummi-Zeitung (Berlin)*, vol. 45, no. 9, Nov. 12, 1930, pp. 333-336. Laufenberg and others have shown increasing water impermeability of films with increasing content of organically bound lead; author's tests in Government experimental station in Berlin-Dahlem to ascertain cause of varying behavior of red-lead linseed-oil mixtures; necessity is shown of careful selection of specially suitable red lead for impregnated cables, such as will improve action of linseed oil by formation of organic lead compounds.

TELEGRAPH, TRANSATLANTIC. Advances in Transoceanic Cable Technique, H. Mason. *Inst. Radio Engrs.—Proc.*, vol. 18, no. 12, Dec. 1930, pp. 2176-2191, 3 figs. Progress in construction of transatlantic cables is described from earliest to most recent type, which operates at 1400 letters per min. without technical detail development of cable operating mechanisms is sketched indicating improvement which resulted from use of relays, magnifiers, and regenerators; application to cable art of land-line multiplex telegraph practice is shown.

TESTING. Portable Kenetron Housing Design, C. W. Evans. *Elec. World*, vol. 96, no. 26, Dec. 27, 1930, pp. 1178, 1 fig. Design is for 100-kv. cable testing set and it contains every facility for rapid routine testing; frame work is 2 by 4-in. scantling and roof and sides are of shiplap; floor is of 1 by 8-in. boards, and frame is assembled with bolts and screws.

PAPER INSULATED. Reduces Cable Ionization by Super-Vacuum Process, S. J. Rosch and H. G. Burd. *Elec. World*, vol. 96, no. 25, Dec. 20, 1930, pp. 1132-1135, 7 figs. For one year process has been used at Hastings-on-Hudson plant of Anaconda Wire & Cable Co., that has been particularly effective in removing occluded gases and moisture from compound and paper insulation before it is impregnated in preventing contamination between steps in process, with result that very low power factor is obtained even at high unit stresses.

RADIO INTERFERENCE. Simultaneous Atmospheric and Cable Interference (Gleichzeitige Luft-und Kabelstoerungen), M. Baeumler. *Elektrische Nachrichten-Technik (Berlin)*, vol. 7, no. 8, Aug. 1930, pp. 325-330, 15 figs. Report on measurements by Haak and O. Fuchs on simple wire Emden-Vigo cable in order to study simultaneous occurrence of interference in cable and in ether.

SUBMARINE INSULATION. Paragutta, A New Insulating Material for Submarine Cables, A. R. Kemp. *Franklin Inst.—Jl.*, vol. 211, no. 1, Jan. 1931, pp. 37-57, 9 figs. Extended study was undertaken of causes of losses and other electrical weaknesses of submarine insulation and search has been made for better materials; as result of this investigation insulation called paragutta has been developed which as name suggests is derived essentially from rubber and gutta percha. Bibliography.

Circuit Breakers

OIL. Modern Switchgear. *Engineer (Lond.)* vol. 150, no. 3910, Dec. 19, 1930, pp. 674-675, 7 figs. Type RM circuit breaker rated at 4000 amperes at 12,000 volts with breaking capacity of 1,000,000 kva, this being, it is said, largest horizontal draw-out metal-clad switchgear unit that has been built; special feature of new Reyrolle type is complete separation of phases in circuit-breaker portion of gear.

Commutators

FAILURE. Oil Seepage Causes Commutator Failures, W. O. Hurlburt. *Elec. West*, vol. 66, no. 1, Jan. 1, 1931, pp. 24-25, 3 figs. Systematic recording and observation of commutator failures has led to conclusion that in majority of cases, primary cause of breakdowns can be attributed to seepage of oil from bearings; most records were made from motors in elevator service subjected to rotation reversal, although unidirectional machines showed identical tendencies.

Condensers

SYNCHRONOUS. Synchronous Condensers and Capacitors. *Power Plant Eng.*, vol. 35, no. 1, Jan. 1, 1931, pp. 93-94, 4 figs. Correction of low power factor by means of synchronous or static condensers.

Conductors

ELECTRIC. Control Contacts and Arc Lengths, W. B. Kindy. *Elec Jl.*, vol. 27, no. 12, Dec. 1930, pp. 727-728, 2 figs. Characteristics of arc which is drawn when low capacity, low-voltage, d.c. circuit is opened by set of contacts in design of control circuits of modern automatic and remotely controlled electrical equipment, are discussed.

ALUMINUM. The Jointing of Steel Cored Aluminum Conductors. *Engineer (Lond.)*, vol. 150, no. 3910, Dec 19, 1930, p. 688. Tests have been made at Prescot Works of British Insulated Cables, Ltd., on firm's patented aerial cable union, and tests show that this type of joint complies fully with requirements.

INSULATION. Ueber die Beflechtung isolierter Leitungen (Braiding of Insulated Wire) K. Sieber. *V. D. I. Zeit.*, vol. 74, no. 51, Dec. 20, 1930, pp. 1735-1738, 7 figs. Influence of thickness of braid and of braiding angle on quality and costs of braiding; mathematical analysis of braid thickness, braiding costs, etc.

LIQUID. New Experiment for Demonstrating the "Pinch" Effect (Ein neuer Versuch zur Demonstration des "Pinch" Effektes), E. Blaich. *Elektrotechnik und Maschinenbau (Vienna)*, vol. 48, no. 49, Dec. 7, 1930, pp. 1083-1085, 4 figs. Experiment which shows that motions in liquid conductors, as noticed for instance in induction furnace, find their principal cause in electromagnetic processes.

Control

REGENERATIVE. Regenerative Control with Compound Motors on Paris Tramways, M. Bacqueyrisse. *Tramway and Ry. World. (Lond.)*, vol. 68, no. 24, Nov. 13, 1930, pp. 275-281 and (discussion) 281-283, 11 figs.; see also editorial comment on p. 274. Design principles, simplification and improvements of regenerative control equipment; permanent coupling of motors; abolition of series-parallel transition; arrangement of motors in series; controller of reduced size; traction equipment with compound motors built by Alsthom Company, for "L" type cars on Paris street railroad two and three-car trains. Paper read before International Tramways and Light Rys. Union, Paris.

Regenerative Control with Compound Wound Motors (Stromrueckgewunnung mit Verbundmotoren), W. Mattersdorff. *Verkehrstechnik (Berlin)*, no. 50, Dec. 12, 1930, pp. 657-660, 3 figs. Results obtained at Session of Internationaler Strassenbahn and Kleinbahnverein, October 1930, in Paris with respect to problem; various systems of regenerative control; Bacqueyrisse connection.

Controllers

ELECTRIC. Electrical Control Gear. *Engineer (Lond.)*, vol. 150, no. 3911, Dec 26, 1930, pp. 714-715, 4 figs. Control gear made by Laurence, Scott, and Electromotors, Ltd. for machines intended for balancing large turbine rotors weighing 17 tons or more; gear of this type has been supplied to Royal dockyards and to several private shipyards.

Converters

FREQUENCY. Frequency Converters for A. C. Railroad Electrification, L. G. Smith. *Nat. Elec. Light Assn.—Bul.* vol. 17, no. 12, Dec. 1930, pp. 755-757, 6 figs. How to meet problem of single phase electrification; types of converters available; factors to consider in selection; design features of single phase generators; types of phase balances available; comparative costs and losses.

Cranes

ELECTRIC. Repulsion Motor as Crane Motor (Der staendergespeiste Einphasenkommutatormotor (Repulsionsmotor) als Kranmotor), R. Richter. *Foerdertechnik und Frachtverkehr (Wittenberg)*, vol. 23, no. 23 and 26, Nov. 7, 1930, pp. 439-443, and Dec. 19, pp. 494-497, 6 figs. Nov. 7: Tests made on portal crane which has four repulsion motors, for hoisting, slewing, crane travel on portal and portal travel, show that for alternating current, these motors are well suited as crane motors; description of crane and result of tests with hoisting motor; Dec. 19: Result of tests with slewing and travel motors; operation characteristics and construction of one phase repulsion motors.

Diesel-Electric Plants

Practical Building Pointers for Diesel Engine Plants. *Diesel Power*, vol. 8, no. 12, Dec. 1930, pp. 632-634, 2 figs. Plan of plant designed to avoid wasting building volume on accessories.

COSTS. Operating Cost of Diesel Engine (Sul costo di esercizio dei motori Diesel), G. Colajanni. *Energia Elettrica (Milan)*, vol. 7, no. 10, Oct. 1930, pp. 864-866. Review of relative importance of various items of operating expenses based on Italian experiences.

GREAT BRITAIN. An Oil-Engined Central Station. *Power Engr. (Lond.)*, vol. 25, no. 297, Dec. 1930, pp. 461-465, 8 figs. Layout and constructional features of Dunoon electricity undertaking; main engines supplied by Davey Paxman & Co., Ltd.; 5-cylinder sets developing 345 b. hp. at 300 r. p. m.; vertical 4-stroke cold-starting Diesel engine with patent spring-injection systems for fuel admission; cooling water system and auxiliary plant; electrical system.

SLATER, MO. High Cost of Smoke and Cinders Cut by Slater, Mo., Diesels, R. R. Howard. *Diesel Power*, vol. 8, no. 12, Dec. 1930, pp. 618-620, 3 figs. Plant equipped with five totalling 1500 hp., each complete with engine, alternator, exciter, and switchboard

panel with voltmeter, ammeters, indicating kilowatt meter and totalizing kilowatt-hour meter.

WEST VIRGINIA. Diesel Plant Generates Power for Price Hill, J. H. Edwards. *Coal Age*, vol. 35, no. 11, Nov. 1930, pp. 654 and 664, 5 figs. on 654. Largest Diesel installation in United States erected to furnish power exclusively for coal mining, in Raleigh County, W. Va.; four 360-hp. vertical engines, each direct-connected to 300-kva. 2400-volt generator, all in building 40 by 60 ft.

Electric Drive

CARGO HANDLING. Alternating Current Gaining for Materials Handling Drives, J. W. Speer. *Matls. Handling and Distribution*, vol. 5, no. 4, Jan. 1931, pp. 53-54, 3 figs. Disadvantages of induction motor; application of a.c. types especially to ore-handling equipment.

IRON AND STEEL PLANTS. Electrical Developments in the Iron and Steel Industry for 1930, D. W. Dean. *Rolling Mill Jl.*, vol. 4, no. 12, Dec. 1930, pp. 651-656, 5 figs. Discussion of extensive application of electrical equipment to rolling-mill drives, their auxiliaries and related steel-mill equipment; total horsepower applied to main drive motors for year ending December 1, 1930 was 151,540 as compared with 139,350 for preceding year.

Electric Equipment

DESIGN. Electric Field Records Notable Progress. *Power*, vol. 73, no. 1, Jan. 6, 1931, pp. 27-29, 5 figs. Turbine-driven 200,000-kva. generators to operate at 1800 r. p. m.; first hydrogen-cooled generator goes into operation; field for outdoor type of machines widened; mercury-arc rectifier applications increase rapidly new system of motor control.

FLASHOVER. The Influence of Altitude Upon the Flashover and Sparkover Characteristics of Electrical Equipment, S. Whitehead and W. D. Owen. *World Power* (*Lond.*), vol. 14, no. 83, Nov. 1930, pp. 404-414, 21 figs. partly on supp. plates. General nature of dependence of sparkover voltages upon air density; general principles, together with formulas for simple cases; it is shown that, for small changes, discharge voltage is roughly proportional to air density; effect of altitude on air density; different theoretical treatments are discussed and formulas for effect developed; these are criticized, and most appropriate methods of attacking problem are indicated.

SELF-SYNCHRONIZING. The Versatility of Application of Selsyn Equipment, R. A. Corby. *Gen. Elec. Rev.*, vol. 33, no. 12, Dec. 1930, pp. 706-711, 13 figs. Typical installations of indicators and control devices list showing some of uses to which Selsyn apparatus has been adapted with decided advantage; as remove control devices and as remote indicators.

TESTING. The Testing of Protective Gear, W. Wilson. *World Power*, vol. 15, no. 85, Jan. 1931, pp. 17-22, 9 figs. Principles and methods that are made use of in various testing operations to which apparatus is subjected.

Elevators

CONTROL. Electric Levelling Gear for Lifts. *Engineering* (*Lond.*), vol. 130, no. 3387, Dec. 12, 1930, pp. 742-743, 6 figs. Arrangement devised and patented by M. D. Scott, of Marryat and Scott, London, known as Levelectric, employs two motors, smaller being mounted above larger to economize floor space.

ELECTRIC. Higher Car Speeds Proposed for Elevators. *Power*, vol. 73, no. 1, Jan. 6, 1931, pp. 30-31, 2 figs. Developments nearing accomplishment are car speeds of 1200 ft. per min., double-deck cars serving two floors at a time and local and express cars in same hoistway.

Modern Lifts, L. S. Atkinson. *Elec. Times*, vol. 79, no. 2045, Jan. 1, 1931, pp. 5-8, 3 figs. Recent developments and latest types in use.

Electric Lines

AERIAL SURVEYING. Aerial Survey for Transmission Line Location, F. G. Dana. *Civil Eng.* (*N. Y.*), vol. 1, no. 4, Jan. 1931, pp. 249-252, 7 figs. Aerial methods adopted on Bagnell transmission-line location; use of stereoscope for binocular study of overlapping photographs; standard flying equipment used; ground field work; comparison of costs of aerial surveys with direct contact prints and with enlarged prints and ground controls.

PROTECTION. Selective Protection of Two Parallel Feeders with Small Resistance, L. A. Lentin. *Electritchestvo*, no. 20, Oct. 1930, pp. 804-807, 5 figs. Problem of selective protection of two parallel feeders fed on both sides by parallel working power stations is analyzed.

Engineering

HUMAN ASPECTS. Engineering Encounters Human Nature, E. D. Smith. *Mech. Eng.*, vol. 53, no. 1, Jan. 1931, pp. 1-4. Engineer, in launching new technological processes in old world, is not merely putting new wine into old bottles; he is putting high voltage into old wiring; it is important part of task of engineering to see that wiring is made adequate to new load; social responsibility incurred by engineer; effect of introduction of automatic loom in two cases; when technological developments pass from ideas to realities, engineering encounters human nature; engineer's responsibility for adapting mechanism to man.

Furnaces

ENAMELING. Welded Furnaces Meet all Requirements. *Welding Engr.*, vol. 15, no.12, Dec. 1930, pp. 33-36, 12 figs. Application of welding in electric furnaces and conveyors of vitreous-enameling plant of Edison General Electric Appliance Co., manufacturers of "hotpoint" electric appliances, Chicago, Ill.; data on operation and temperatures.

HEAT TREATING. The Use of Electricity in the Heat Treatment and Welding of Metals, A. N. Otis and W. L. Warner. *Mill and Factory Illustrated*, vol. 5, no. 1, Jan. 1930, pp. 48-50, and 92, 9 figs. Features of electrically-heated water-sealed furnaces of Kenworthy type widely used for bright annealing copper wire and similar products.

HIGH FREQUENCY. High Frequency Induction Heating, H. Smethurst, Jr. *Instn. Engrs.—Jl.*, vol. 41, part 3, Dec. 1930, pp. 113-130, 9 figs. History of development; comparison of types.

INDUCTION. Tonnage Melting by Coreless Induction, E. F. Northrup. *Iron Age*, vol. 127, no. 3, Jan. 15, 1931, pp. 228-233, 7 figs. Operating principles and application of high-frequency induction furnaces including data on power requirements, size of furnaces and refractory materials.

Fuses

TESTING. The Detection of Transient Arcs in Metal-Clad Fusible Cutouts, P. D. Morgan and H. W. Baxter. *Instn. Elec. Engrs.—Jl.* (*Lond.*), vol. 69, no. 408, Dec. 1930, pp. 95-99, 8 figs. Directions for employment of neon lamp as substitute for oscillograph in detection of transient low-current arcs between case and poles of metal-clad fusible cut-outs operating under short-circuit conditions. Bibliography.

Generators

DESIGN. Impulse-Short Circuit Generators (Stosskurzschlussgeneratoren), F. Niethammer. *Elektrotechnik und Maschinenbau* (*Vienna*), vol. 48, no. 49, Dec. 7, 1930, pp. 1077-1083. For practical testing of high capacity electric circuit breakers with actual short-circuit capacities, so-called impulse short circuit generators are used in test stands; fundamentals of design of such generator are given.

Increase in Use of Single Element Generators Shown by Survey. *Power Plant Eng.*, vol. 34, no. 24, Dec. 15, 1930, pp. 1418-1422, 2 figs. Study of generating equipment installed in principal power plants of country indicates tendency toward use of large single-element generators rather than double or triple-shaft design inaugurated several years ago; largest single-element machine in use is 160,000 kva. machine in East River station; table illustrating electric-generator practise in 25 power plants.

EXCITATION. Excitation of Generators (Bektachtiging van Generatoren), M. van der Veen. *Polytechnisch Weekblad* (*Amsterdam*), vol. 24, no. 50, Dec. 11, 1930, pp. 851-853, 6 figs. Mathematical analysis by which attempt is made to show along theoretical lines that assumption that magnetizing characteristic of automatically regulated generator should be linear saturation curve, must be incorrect.

SYNCHRONOUS. Permissible Errors in Synchronizing Generators, H. S. Baker. *Elec. News*, vol. 40, no. 1, Jan. 1, 1931, pp. 35-36. Analysis of two common errors, i. e. number of electrical degrees of phase difference between generator and bus at instant of breaker closure; and difference in speeds of generator and bus.

WATERWHEEL. Niagara's Latest Unit. *Elec. News* (*Toronto*), vol. 39, no. 24, Dec. 15, 1930, pp. 65-66, 2 figs. Power plant was finally completed with installation of tenth 58,000 hp. waterwheel-driven generator at Queenston generating station of Hydroelectric Power Commission of Ontario; unit has generator rating of 55,000 kv.a., 12 kv., 80 per cent p. f., 25-cycle, 187.5 r. p. m., while hydraulic turbine is rated at 58,000 hp. at 294 ft. head; total installed generator capacity of this station is now 497,000 kv.a.; enclosed air cooling is applied.

Illumination

INTERNATIONAL CONGRESS. International Illumination Congress, 1931. *Engineer* (*Lond.*), vol. 150, no. 3909, Dec. 12, 1930, p. 646. Congress being arranged by National Illumination Committee of Great Britain, in cooperation with Illuminating Engineering Society; will be held under auspices of International Commission on Illumination, and will take place during September of 1931.

Insulating Materials

PAPER. Paper in the Electrical Industry, W. H. Anderson. *Paper Mill*, vol. 7, no. 52, Dec. 27, 1930, pp. 11-12, and 14. Uses and application of paper in manufacturing electric equipment discussed under headings: condenser paper, wire wrapping paper, paper for laminated phenotic products, mica wrappers, condenser brushing paper, pressboard or fullerboard. Paper presented before Tech. Assn. Pulp and Paper Industry, Dec. 9, 1930.

TEXTILES. Treated Fabrics, A. R. Dunton and A. W. Muir. *Elecn.* (*Lond.*), vol. 105, no. 2741, Dec. 12, 1930, pp. 744-747, 8 figs. Notes on their use for insulating purposes; varnished fabrics and tapes.

Insulators

DESIGN. Designing Insulators to Combat Fog, S. M. Jones. *Elec. World*, vol. 96, no. 25, Dec. 20, 1930, pp. 1139-1142, 6 figs. Deposits are primary cause and fog itself only secondary cause of breakdown; surface leakage resistance is real criterion of performance; suspension string length factor; computing surface leakage resistance; adapting pin design to suspension use.

Lamps

LIFE. Life of Vacuum and Gas Filled Wendel Lamps and Causes of their Burning Out (Ueber die Lebensdauer der luftleeren und gasgefuellten Wendellampen und die Ursachen ihres Durchbrennens), F. Koref and H. C. Plaut. *Zeit. fuer Technische Physik* (*Berlin*), vol. 11, no. 12, 1930, pp. 515-521, 1 fig. Energy consumption are calculated and relation of these to life of lamps are analyzed.

NEON. Neon Lamps (Sulle lampade a neon), N. Carrara. *Nuovo Cimento* (*Rome*), vol. 7, no. 8, Aug.-Sept.-Oct. 1930, pp. 318-325, 10 figs. partly on supp. plate. Experimental study of photoelectric sensitiveness of commercial neon lamps manufactured by Philips, Osram etc.

Lighting

AIRPORT. The Application of Illuminating Engineering Principals to Landing Field Floodlighting, L. C. Simpson *Airports*, vol. 6, no. 1, Jan. 1931, pp. 12-13 and 30, 8 figs. Fundamental considerations of satisfactory landing field floodlighting are illustrated by sketches.

New Styles in Lights, H. C. Ritchie. *West. Flying*, vol. 8, no. 6, Dec. 1930, pp. 59-61, 5 figs. Use and operation of various types of lighting equipment, including beacon, floodlights, boundary lights, etc.; data on power consumption and locating.

MACHINE SHOPS. Lighting the Machine Shop, M. Warren. *Modern Machine Shop*, vol. 3, no. 7, Dec. 1930, pp. 11-14, 16, 18 and 48, 7 figs. Investigation of plants of various companies show effect of proper lighting on efficiency; graph illustrates relation between voltage and light intensity.

Loud Speakers

PROGRAM SERVICE. Latest in Amplifiers and Loudspeakers, W H. Hutter. *Telephony*, vol. 99, no. 25, Dec. 20, 1930, pp. 20-22. New developments in program service amplifiers and loudspeakers; origin of amplifiers and evolution with radio sets. Address read before U. S. Independent Telephone Assn.

Measuring Instruments

ELECTRIC. Switchboard Instruments. *Power Plant Eng.*, vol. 35, no. 1, Jan. 1, 1931, pp. 39-40. Instruments for measurement of voltage, current, power, etc.; instruments for various types of panels; alternating current generator circuits.

Motors

PROTECTION. Modern Methods of Enclosing Electric Motors, P. W. Arnold. *Mill and Factory Industrial*, vol. 8, no. 1, Jan. 1931, pp. 53-55, 13 figs. Problem which arise in protecting motors; most common enclosures; recent developments in enclosing motors.

Built-In Motor Protection, G. R. Anderson. *Indus. Eng.*, vol. 88, no. 12, Dec. 1930, pp. 605-607, 4 figs. Providing protection for inclosed ventilated types. (Continuation of serial.)

RAILROAD. Improvements on Street Car Motors and their Suspension (Perfectionnements apportes aux Moteurs de Tramways et à leur suspension), Castaing. *Industrie des Voies Ferrees et des Transports Automobiles* (*Paris*), vol. 24, no. 287, Nov. 1930, pp. 310-342, 28 figs. Notes with respect to current; supply voltage; operating conditions, modern developments as to magnetic and electric characteristics, mechanical improvements and systems of installation.

SPEED REGULATION. The Rossman System of Speed Control for Alternating-Current Motors. *Engineering* (*Lond.*), vol. 130, no. 3385, Nov. 28, 1930, pp. 694-695, 7 figs. Method is being used in number of American power stations, more particularly for driving forced-draft and induced-draft fans, though it is also applicable to feed pumps and other variable-speed equipment; driving unit consists of constant-speed a.c. motor of either synchronous or induction types, and variable-speed shunt-wound d.c. motor of much smaller output.

Networks

CALCULATION BOARDS. Representation of Generators on an A. C. Calculating Board, W. W. Parker. *Elec. Jl.*, vol. 27, no. 12, Dec. 1930, pp. 718-719, 4 figs. Means for representing synchronous machines; three-phase generator can be represented by single-phase proportional to actual phase-to-neutral terminal or internal voltage; schematic diagram of regulator and phase shifter arrangement for producing power for a.c. calculating board; equipment is described.

INTERCONNECTED. Synchronism Automatically Checked by Substations of Alabama Power Company, E. B. Henry and W. B. Morton. *South. Power Jl.*, vol. 48, no. 12, Dec. 1930, pp. 63-65, 3 figs. Function of synchronism check scheme is to check synchronism between two or more sources of power that are normally in continuous state of synchronism due to interconnection at another station; six synchronism check schemes now in automatic operation; system installed at Montgomery primary substations; operation under normal set-up; protective features.

LIGHTNING. Development of Electric Distribution Networks and Lightning Hazards (Le développement des réseaux de distribution d'énergie électrique et les dangers de la foudre), A. Boutaric. *Revue Générale de l'Electricité* (*Paris*), vol. 28, no. 22, Nov. 1930, pp. 865-872, 2 figs. Possible influence of overhead network systems on bringing about of electric lightning storms and danger of lightning for individuals and objects near line is analysed.

OVERVOLTAGES. Investigation by Means of Cathode Ray Oscillograph of Excess Voltages caused by Short-Circuit in 8 kilo-volt Distribution Network (Untersuchungen mittels Kathodenstrahl-Oszillograph der durch Erdschluss hervorgerufenen Ueberspannungen in einem 8 k V-Verteilnetz), K. Berger. *Schweiz. Elektrotechnischer Verein* (*Assn. Suisse des Electriciens*)—*Bul.* (*Zurich*), vol. 21, no. 23, Dec. 7, 1930, pp. 756-788, 47 figs. Magnitude and development of excess voltage dependent on location of short circuit; action of obsolete protective equipment and behavior of induction regulator and current transformers are analyzed; deductions are made with respect to insulators.

PLANNING. A Master Plan for Sound Growth in System Expansion. *Elec. News*, vol. 40, no. 1, Jan. 1, 1931, pp. 31-32 and 34. Through coordination and planning it is possible for modern light and power system to get most effective and economical use of money, men and equipment needed; it is possible to operate and build utility in terms of economic facts and business principles whereby waste is eliminated and maximum values are had from current investments.

Oscillographs

CATHODE-RAY. The Position of Cathode Ray Instruments in the Field of Oscillography, O. Ackerman. *Instruments*, vol. 3, no. 12, Dec. 1930, pp. 775-777. Proper field of cathode-ray instruments starts where limitations of moving-coil instruments are reached, i. e., in recording of frequency phenomena over 5000 cycles per sec.; in study of single phenomena (occurring at random) where phenomenon itself must start process of recording with less than 1/50th of sec.; in measuring voltages with negligible loss of power (electrostatic methods); in direct recording of relations where abscissa is electrical quantity; in cases where good visibility of registrations of instrument is required.

Phase Advancers

The Theory and Performance of Phase Advancers, J. J. Rudra and M. Walker. *Instn. Elec. Engrs.—Advance Paper*, 1930, 25 pp., 37 figs. Paper divides advancers into "expedor" advancers in which voltage is proportional to secondary current, and "susceptor" advancers in which it is proportional to secondary voltage; complete theory of expedor advancer is worked out from equivalent circuit, and test results are compared with what might be expected from theory; comparison of advancers of different phase angles under different conditions is made to determine which is best for given purpose; equivalent circuit of susceptor advancer is given and from it complete theory is worked out.

Piezoelectric Quartz

Summary of Piezo-Electric Crystal Conference Held by U. S. Navy Department, December 3-4, 1929. *Inst. Radio Engrs.—Proc.*, vol. 18, no. 12, Dec. 1930, pp. 2128-2135, 3 figs. For purpose of bringing about uniform understanding among conferees, representatives of Naval Research Laboratory offered for discussion; resumé of crystallography and piezoelectricity of quartz; description of methods of cutting and testing quartz used at Naval Research Laboratory; account of experience and practices of laboratory relative to two principal "cuts" used in art.

Power Industry

Congress of the International Association of Producers and Distributors of Electric Power in Brussels, September 1930 (Congrès de Bruxelles de l'Union internationale des Producteurs et Distributeurs d'Energie électrique (Septembre 1930). *Revue Générale de Electricité* (*Paris*), vol. 28, no. 23, Dec. 6, 1930, pp. 885-894. Grounding of neutral in high and low tension networks; parallel operation of generating stations; joint operation of high tension lines and telephone communication lines.

EMPLOYEES TRAINING. Possible Executives in the Making, J. R. Martin. *Elec. Light and Power*, vol. 8, no. 12, Dec. 1930, pp. 40-43, 1 fig. President's Training Course in Management as originated by Britton I. Budd, president of Public Service Co. of Northern Illinois, is described; company operates in territory approximating 6000 sq. mi. surrounding Chicago, and serves some 318 communities, principally with electricity and gas; approximately 5000 men and women are employed; reasons for selecting number of employes to participate in course in management, and principles and policies governing its administration are set forth.

Power Supply

RURAL. Farm-Service—What of the Future, K. R. Mackinnon. *Elec. World*, vol. 95, Mar. 29, 1930, pp. 657-660, 2 figs. Central-station industry has not evolved coherent and workable policy of national scope for farm service extensions; author cites practices and policies of Nebraska Power company but not necessarily because these are thought to be answer to national problem.

Radio

AERIAL TRANSPORTATION. Wireless Direction Finding, C. B. Carr. *Aircraft Eng.* (*Lond.*), vol. 2, no. 22, Dec. 1930, pp. 305-307. Relative merits of various directional-transmission and reception systems for purpose of assisting air operating company in selection of proper equipment; principles of equi-signal and rotating beacon; Marconi-Bellini-Tosi system; Marconi-Adcock system; Marconi-Robinson system.

The Development of Visual Type of Radio Range Transmitter Having A Universal Application to the Airways, W. E. Jackson and S. L. Bailey. *Inst. Radio Engrs.—Proc.*, vol. 18, no. 12, Dec. 1930, pp. 2059-2101, 35 figs. Visual type of radio range which has universal application to civil airways of United States; relative merits of aural and visual systems of course indication, theory of production of 12 courses by utilizing three-phase radio-frequency source is presented; general description of transmitter; necessary requisites of goniometer design; performance curves of final goniometer illustrate effect of these factors on results.

Aircraft Radio Telephone Successful, R. Johnson. *Telephony*, vol. 99, no. 26, Dec. 27, 1930, pp. 31-32, 2 figs. Demonstration by Air Transport Co. proves that plane-ground voice communications are not only practicable, but successful; discussion of other developments in air transport communication in 1930.

AIRPLANES. System of Guiding Airplanes (Sur un procédé de guidage des avions), Biolt. *Onde Electrique* (*Paris*), vol. 9, no. 103, Nov. 1930, pp. 520-526, 1 fig. System allows for exact location of plane when traveled traject is known; to this end interference zone is created between 2 synchronous emissions and meter installed on receiver of airplane which records number of successive maxima and minima: from this, course traveled is deduced.

AMPLIFIERS. An Amplifier for Measuring Small Currents, R. D. Bennett. *Rev. Sci. Instruments*, vol. 1, no. 8, Aug. 1930, pp. 466-470, 5 figs. Amplifier is described which uses four-electrode tube of ordinary type, and gives maximum current sensitivities of order of 10 to 18 type, and gives maximum current sensitivities of order of 10 to minus 18 power amperes; novel feature consists in using as grid leak positive ion emission of filament.

DESIGN. Effect of Output Load upon Frequency Distortion in Resistance Amplifiers, H. A. Thomas. *Experimental Wireless*, vol. 8, no. 88, Jan. 1931, pp. 11-17, 11 figs. Simple mathematical analysis pertaining to loudspeaker load, input impedance of power-tubes stage, anode circuit impedance of stage 2, amplification of stage 2, input impedance of stage 2, anode circuit impedance of stage 1, amplification of stage 1, overall amplification; experimental results; results obtained; case of 3 stages of low amplification factor tubes; amplification curves.

CONDENSERS. A Variable-Capacitance Cylindrical Condenser for Precision Measurements, and a Wavemeter for Short Wavelengths, E. B. Moullin. *Instn. Elec. Engrs.—Advance Paper received* Nov. 13, 1930, 12 pp., 19 figs. Cylindrical condenser which has been developed for precision measurements at very high radio frequencies; one cylinder is always totally enclosed by other and capacitance is varied by altering distance between axes of cylinders; paper also includes tentative design for short range short wave absorption wavemeter in which same principles of construction are used.

FREQUENCY MEASUREMENT. A New Method of Measurement of Resistance and Reactance at Radio Frequencies, F. M. Colebrook and R. M. Wilmotte. *Instn. Elec. Engrs.—Advance Paper received* Nov. 29, 1930, 10 pp., 9 figs. Method of measuring radio frequency resistance of coils is described; it depends on change in reactance of tube controlled oscillating circuit when it is coupled to circuit under investigation, and does not require any measurement of current or voltage; practical details of working of method and construction of necessary apparatus are given.

GENERATORS. Power Equipment for Aircraft Radio Transmitters, J. D. Miner. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 1, Jan. 1931, pp. 59-77. Systems of power equipment now used or contemplated for supplying power to aircraft radio transmitters; various types of power equipment are described and advantages and disadvantages of each type are discussed.

Power for Aircraft Radio, F. C. Doughman. *Elec. Jl.*, vol. 27, no. 12, Dec. 1930, pp. 701-704, 10 figs. Generators used to supply power for aircraft radio can be driven in wide variety of ways, depending upon size of plane, service for which it is designed, and amount of power required; alternator of inductor type can be combined with d.c. motor to make highly efficient battery driven aircraft unit; oldest and best known type of aircraft power equipment is storage battery driven d.c. dynamotor; constant-speed propeller has made possible use of wind-driven alternator; equipment is illustrated.

Railroads

ELECTRIC. The Contribution of Modern Electrical Equipment to Transportation. H. L. Andrews. *N. Y. Railroad Club—Proc.*, vol. 41, no. 1, Nov. 1930, pp. 9369-9399, 26 figs. and charts. Savings due to electric equipment for street-car lines, trolley buses, gas-electric buses, and electrified steam-railroad transportation systems.

SIGNALS AND SIGNALING. Pennsylvania Installs Centralized Control on 30.3 Miles of Single Track. *Ry. Signaling*, vol. 23, no. 12, Dec. 1930, pp. 434-436, 4 figs. Pennsylvania has completed installation of centralized traffic control between Ben Davis, Ind., and Almeda, which is portion of main line between Indianapolis, Ind., and St. Louis, Mo.; characteristics of line and traffic; 12 min. saved on each freight train stop; second tracking deferred; first installation of Union three-wire coded system.

Remotely-Controlled Interlocking Reduces Operating Costs, R. L. Davis. *Ry. Signaling*, vol. 23, no. 12, Dec. 1930, pp. 429-430, and 433, 4 figs. Michigan Central replaces mechanical plant at crossing of Michigan Central and Grand Trunk Western at Rochester Jct., Mich.; annual saving of $5000 in operating expenses.

Rectifiers

HARMONICS. The Calculation of Harmonics in Rectified Currents, E. L. E. Wheatcroft. *Instn. Elec. Engrs.—Jl.* (*Lond.*), vol. 69, no. 408, Dec. 1930, pp. 100-108, 9 figs. New mathematical method is proposed which treats rectifier characteristic as continuous curve; method of reducing equations to tractable

form for solution by successive approximations, using algebra of plane vectors; it is shown by means of numerical example how approximations converge on true value deduced by classical method.

MERCURY ARC. Mercury Arc Rectifier Equipment for the Melbourne Tramways. *Engineer* (*Lond.*), vol. 150, no. 3909, Dec. 12, 1930, pp. 655-656, 5 figs. Largest equipment sent to Australia for Melbourne street railroad has capacity of 500 kw., and is designed to operate on 6600-volt, three-phase system and to feed into 600-volt d.c. two-wire system, plant being arranged for fully automatic control; sub-station is brought into operation by means of voltage relay and /or time switch, and is shut down by means of low-current relay or time switch.

Relays

A Thermal Overload Relay, A. E. Capon. *Elec. Jl.*, vol. 27, no. 12, Dec. 1930, pp. 708-709, 4 figs. Relay differs from other thermally operated relays in that heat storage is contained within heater element itself, without any external heat-storing agency; characteristic was obtained by using heater coil of comparatively large mass; to provide protection against instantaneous overload, additional tripping device is connected in series with heating element; operating characteristics with various stationary contact settings, is given in curves.

Resonance

ELECTRIC CIRCUITS. Theory of Two Coupled Oscillatory Circuits (Zur Theorie zwier gekoppelter Schwingungskreise, I), V. Petrzilka. *Elektrische Nachtrichten-Technik* (*Berlin*), vol. 7, no. 8, Aug. 1930, pp. 317-324, 6 figs. Method of calculation of resonance curves of two circuits from energy supplied to them.

Switchboards

REMOTE CONTROL. Miniature Remote Control Switchboards, L. J. Cissna. *Elec. Jl.*, vol. 27, no. 12, Dec. 1930, pp. 689-695, and 717, 12 figs. Miniature remote-control switchboards represent one of latest developments in switchgear apparatus; development; mounting of control equipment; auxiliary relays; remote metering; wiring; power supply; circuits and their operation; substation equipment; advantages.

STEEL. Development of the Modern Steel Switchboard, E. G. Bern and F. E. Jaquay. *Elec. Light and Power*, vol. 8, no. 12, Dec. 1930, pp. 54, 56 and 58, 7 figs. Development and comparison between older and modern equipment; various examples of modern steel switchboards are illustrated.

Switchgear

METAL CLAD. Metal-Clad Switchgear, R. O. Waltham. *Elec. Light and Power*, vol. 9, no. 1, Jan. 1931, pp. 35-37, 7 figs. Before any manufacturer in United States was ready to supply this type of apparatus, Public Service Co. imported complete distribution substation installation of Reyrolle 4-kv. metal-clad gear and placed equipment in service at Bellwood substation in 1926; experience resulted in development of number of features to adapt gear to American operating conditions which were incorporated in gear subsequently manufactured by Allis-Chalmers Co. under Reyrolle patents.

Telephone

RELAYS. Economics of the Application of Relays to Telephone Circuits, W. W. Wells. *Bell Laboratories Rec.*, vol. 9, no. 5, Jan. 1931, pp. 224-228, 4 figs. To design ideal relay for each particular condition would frequently require design of different relay for each application, and would ultimately result in manufacture of excessive number of types; development of new relay structures, therefore, is not frequently advisable; economic application of existing relay structures; development of new windings and spring arrangements as required.

Trackless Trolleys

MAINTENANCE AND REPAIR. Trolley Buses Cost Less to Maintain than Petrol Buses, C. O. Silvers. *Bus and Coach*, vol. 3, no. 25, Jan. 1931, pp. 3-6, 5 figs. Merits of trackless trolleys as compared to motor bus; tables give data on costs per 100 seat miles; vehicle maintenance and repairs; cost of power and its distribution.

Transformers

CONNECTION. Systems of Transformer Connection. *Power Plant Eng.*, vol. 35, no. 1, Jan. 1, 1931, pp. 44-46, 38 figs. Internal and external connections for various voltage and current combinations.

CONSTRUCTION. Recent Progress in Construction of Transformers of Great Power and Very High Voltage etc. (Recenti progressi nella costruzione dei trasformatori di grande potenza ed altissima tensione considerazioni generali d'impiego), B. Cerretelli. *Elettrotecnica* (*Milan*), vol. 17, nos. 28 and 29, Oct. 5, 1930, pp. 638-646, and Oct. 15, pp. 661-672, 54 figs. General review of progress in design of construction, including theoretical analysis of operation of very large transformers, with special reference to transformers of Cardano and Cislago stations, in northern Italy, of 25,000 to 36,000 kva. and 220,000 volts; also description of 1,050,000-volt transformers built for Societa Pirelli.

MAINTENANCE AND REPAIR. Periodic Care of Transformers Cuts Maintenance Costs, A. A. Fredericks. *Power*, vol. 71, no. 9, Mar. 4, 1930, pp. 354-357, 5 figs. Faults that may develop in transformers and how to remedy them.

MANUFACTURE. Fundamentals of Transformer Construction. *Power Plant Eng.*, vol. 35, no. 1, Jan. 1, 1931, pp. 42-44, 6 figs. Types of cores and windings, leads, casings, methods of mounting and cooling; pole type substation for small industrial installations.

TRANSIENTS. Transient Currents in Transformers, H. M. Turner. *Franklin Inst.—Jl.*, vil. 211, no. 1, Jan. 1931, pp. 1-36, 31 figs. Principles underlying phenomena of transient currents in transformers, when connected to source of power, by starting with simple inductive circuits in permanent state and gradually leading up to more involved case of transformer in transient state; elements affecting transient current are considered individually; appendix describes transient visualizer and oscillograph assembly.

Transmission Lines

GROUND WIRE. The Neglected Ground Wire (Den miskjente jordline), W. R. Blumer. *Elektroteknisk Tidsskrift* (*Oslo*), vol. 43, no. 32, Nov. 15, 1930, pp. 439-444, 8 figs. Importance of equipping towers for electric high-tension lines with ground wires as protection against lightning; several instances reviewed where lack of adequate grounding caused severe damage to towers; constructions of towers of wood and steel used in Germany and Sweden.

LIGHTNING. Lightning Research in the Field and Laboratory, E. Beck. *Elec. Light and Power*, vol. 9, no. 1, Jan. 1931, pp 59, 62 and 64, 10 figs. Investigative program was carried out during summer of 1930; lightning records were made with automatic cathode ray oscillograph of Norinder type which is automatic within itself and begins to register instant that applied surge voltage exceeds normal line voltage; oscillograms of typical waves measured.

MAINTENANCE AND REPAIR. Live Line Tools for High Voltage Maintenance, W. Smith. *Elec. Light and Power*, vol. 8, no. 12, Dec. 1930, pp. 45-46, 48 and 50, 9 figs. New method of making repairs to high voltage lines was introduced a few years ago which is rapidly coming into general use, making it possible to repair, or even rebuild completely, high voltage lines without taking them out of service; this is done by use of so-called "live line tools," with them, work can be done during regular hours, time required being but slightly greater than with line dead; equipment and its application is described. Paper read before Northwest Elec. Light and Power Assn.

PROTECTION. Theory and Application of Relay Systems, P. H. Robinson and I. T. Monseth. *Elec. Jl.*, vol. 28, no. 1, Jan. 1931, pp. 48-51, 12 figs. Impedance relay is dependent for its operation on both excess current and low voltage; this feature is secured by addition of voltage restraining coil to ordinary over-current relay element; transmission lines operated in parallel can best be protected by use of selective differential current relay; selective-differential relay. (Continuation of serial.)

RELAYS. Interstation Control Wires Avoid Cascade Relaying, G. M. Babcock. *Elec. World*, vol. 95, Mar. 29, 1930, p. 646, 1 fig Cascade relaying in transmission-line system causes longest time delay at main switching station, where short-circuit current is greatest and should be cleared quickly to avoid serious disturbance on entire system; ideal relaying scheme is one which will work instantaneously with short circuit on line with which it is identified, but remain inoperative with short circuit on any other part of system; Los Angeles Gas & Electric Corporation has operation relay scheme of this character.

WIND PRESSURE. Measurement of the Wind Pressures on Overhead Lines, R. H. Sherlock. *Nat. Elec. Light Assn.—Bul.*, vol. 18, no. 1, Jan. 1931, pp. 29-34, 11 figs. Methods used to carry on experimental study of strength and loading of pole lines, and brief description of instruments which were developed for study of wind gusts; representative data arranged in form adopted for summarizing and interpreting results; no conclusions are presented.

Vacuum Tubes

AMPLIFICATION. Reduction of Distortion and Cross-Talk in Radio Receivers by Means of Variable-Mu Tetrodes, S. Ballantine and H. A. Snow. *Inst. Radio Engrs.—Proc.*, vol. 18, no. 12, Dec. 1930, pp. 2102-2127, 18 figs. In attempting to control audio output of radio receiver employing present types of tubes by varying control grid bias or screen-grid voltage distortion, due to non-linearity of output-input voltage relation for tube, and cross-talk are encountered at higher signal voltages; two shielded tetrode tubes, designated as types 550 and 551, have been developed to reduce these effects.

APPLICATIONS. Industrial Uses of Electron Tubes, W. R. G. Baker, A. S. Fitzgerald and C. F. Whitney. *Electronics*, vol. 2, no. 1, Jan. 1931, pp. 467-469, 8 figs. Principal objects which are aimed at in applying electron tubes to power control problems; circuits; notes on features of electron tubes; phase relation control; vacuum-tube control of thyratron; thyratron tuned relay; thyratron flasher; methods of controlling output; a.c. output.

Welding

ARC. Facts Concerning A. C. and D. C. Welding, J. C. Holslag. *Welding*, vol. 1, no. 14, Dec. 1930, pp. 992-993. Favorable and unfavorable characteristics of both processes; a.c. machine is 70 to 90 per cent efficient when considered as piece of electrical apparatus, whereas motor generators and resistance apparatus vary from 50 per cent efficiency electrically down to 5 per cent; first cost, installation and operation are all in favor of a.c. welding.

ATOMIC HYDROGEN. Welding with Atomic Hydrogen Process, S. Martin, Jr. *Welding*, vol. 1, no. 14, Dec. 1930 pp. 990-991, and 998, 6 figs. Proper method for welding steel castings, alloy steels, other metals and the repair of dies; pertinent notes on hydrogen.

AUTOMOBILE. Unusual Welding Jobs in Ford Fabrication. *Am. Mach.*, vol. 73, no. 15, Oct. 9, 1930, pp. 586-588, 5 figs. Method used in manufacture of blanks for differential ring gear, axles, radius rods, mufflers.

JOINTS. How Strong are Welded Joints in Tubular Members of Airplanes, H. L. Whittemore and W. C. Brueggeman. *Iron Age*, vol. 126, no 26, Dec 25, 1930, pp. 1925-1926. Paper previously indexed from Am. Welding Soc.—Jl., Sept. 1930.

LOCOMOTIVE BOILERS. Welding Practice on the Illinois Central System. *Boiler Maker*, vol. 30, no. 12, Dec. 1930, pp. 330-335, 7 figs. Rules developed by Illinois Central for fusion welding of locomotive and stationary boilers; instructions for handling oyxgen and acetylene regulations.

MACHINERY. Economies in Welding Machine Parts, J. H. Babcock. *Welding Engr.*, vol. 15, no. 7, July 1930, p. 56, 12 figs. Welded chain guards, gears, wheels, levers and other parts show large savings in cost over riveted construction or castings.

MACHINES. Making Steel Axle Housings by Arc Welding, J. M. Robinson. *Machy.* (*N. Y.*), vol. 37, no. 5, Jan. 1931, pp. 329-330, 3 figs. Method of Oakland Motor Car Co., in producing lightweight rear axle housings by joining steel stampings on automatic arc-welding machine; data on time requirements, tolerances and properties of weld.

New Application of Arc Welding Machine in Street Railroad Practice (Eine Neuartige Verwendung der Lichtbogen-Schweissmaschine im Strassenbahnbetrieb), O. Kranner *Verkehrstechnik* (*Berlin*), no. 33, Aug. 15, 1930, pp. 429-430, 2 figs. Possibility of application of arc welding machine for measuring of rail return joints, equipment of street railroads in Graz.

RESEARCH. Practise in Welding Turns to Research. J. R. Griffith. *Welding Engr.*, vol. 15, no. 12, Dec. 1930, pp 29-31, 1 fig. Effect of operator's skill on welds; investigation conducted at Oregon State College on eccentricity of angle connections: stress distribution of welded joint is little, if at all, better than for riveted joint. Paper presented before Int. Acetylene Assn., Chicago, Ill., Nov. 12-14, 1930.

STEEL BUILDINGS. Welding Applied to Two Buildings. *Eng. News Rec.*, vol. 105, no. 24, Dec. 11, 1930, pp. 925-928, 6 figs. Symposium consisting of two articles: Useful Structural Detail Developed for Large All-Welded Building, J. G. Ritter; Contract and Work Procedure on a 14-Story Field-Welded Building, W. F. Carson and F. P. McKibben; construction of 11-story central engineering laboratory building of Westinghouse Electric and Manufacturing Co.; method of erecting six sections of DuPont office building in Wilmington, Del.

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☐ **30-178**	R. B. George	Power Transformer Noise, Its Characteristics and Reduction
☐ **30-181**	E. E. George	Operating Experiences with Reactance Type Relays
☐ **31-18**	Edward L. Moreland	Lackawanna Suburban Electrification
☐ **31-21**	W. H. Harrison and A. E. Silver	Trends in Telephone and Power Practise as Affecting Coordination
☐ **31-24**	J. C. Martin and H. L. Huber	Status of Cooperative Work on Joint Use of Poles
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Industrial Notes

The Ward Leonard Electric Company, Mount Vernon, N. Y., has appointed the Beedle Equipment Company as sales representative in the Cincinnati and Dayton districts. Offices are located at 1309 Union Trust Building, Cincinnati, Ohio.

Weyerhaeuser Appoints Ray V. Clute.—According to a recent announcement, Ray V. Clute has been appointed manager of cedar pole sales of the Weyerhaeuser Sales Company with headquarters at Chicago. He has been associated with the company since 1916.

New Circuit Breaker.—A new indoor oil circuit breaker with enclosed type mechanism and all poles in one tank, known as type DR-25, has been developed by the Condit Electrical Mfg. Corporation, Boston. This breaker offers the features of non-oil-throwing, greater clearances, quick clearing operation, small space requirements and provision for venting gases. It is furnished three or four pole, manually or electrically operated for 600, 800 and 1200 amperes at 15,000 volts. The estimated interrupting capacity is 2500 amperes at 15,000 volts.

Construction Begins on G-E Cleveland Plant.—Construction of a $1,000,000 plant, the first unit of an extensive development in Cleveland by the General Electric Company has been started by the Austin Company, engineers and builders of Cleveland, and will be completed by August 1. A definite upturn in business and the fact that building costs are the lowest in years were factors leading to the decision to start expansion projects at this time. When completed the new plant will employ 1,000 workers. The project will be erected on a 23-acre site in Euclid, ten miles east of downtown Cleveland, and about three miles from Nela Park, the extensive research laboratories of the company. In the plant will be made all of the wire filament for incandescent lamps, in addition to all gases used in the works of the lamp company.

Trade Literature

Waterwheel Generators.—Bulletin GEA-820A. Describes vertical waterwheel-driven generators. Such units range in size from 30 to 77,500 kv-a. General Electric Co., Schenectady, N. Y.

Arc Welding Supplies.—Bulletin 3304, 20 pp. Describes welding rods, shields, holders, cables, protective clothing, and other accessories. The Lincoln Electric Company, Cleveland.

Turbine-Generator Units.—Bulletin 1835-A. Describes Westinghouse 3600 r. p. m. steam-turbine-generator units. Westinghouse Electric & Manufacturing Company, East Pittsburgh.

Insulator Glaze.—Bulletin, 10 pp. Treats of the glaze of porcelain insulators and its influence on insulator life and strength. Locke Insulator Corporation, So. Charles and Cromwell Streets, Baltimore.

Synchronous Condensers.—Bulletin GEA-1337, 20 pp. Describes small synchronous condensers for improving power factor and for maintaining correct voltage in industrial plants. General Electric Company, Schenectady, N. Y.

Vulcanized Fibre.—Bulletin, 40 pp. Describes "Diamond" vulcanized fibre. The process of manufacture is illustrated and uses of the product, widely applicable in electrical fields, are illustrated. Continental-Diamond Fibre Company, Newark, Del.

Motors.—Bulletin 169, 8 pp. Describes Wagner slip-ring motors, four different types, speed torque characteristics and control equipment necessary for starting. Wagner Electric Corporation, 6400 Plymouth Avenue, St. Louis.

Insulated Aluminum Conductors.—Bulletin, 16 pp. Describes "Alectral" insulated aluminum wires, cables and fittings. The advantages of the new type conductors for various applications are outlined. General Cable Corporation, 420 Lexington Avenue, New York.

Phosphor Bronze—Nickel Bronze.—Bulletins, each 32 pp., describe various alloys of these metals, their characteristics and uses. The Riverside Metal Company, Riverside, N. J.

Relays.—Bulletin GEA-970B, 48 pp. Describes type PQ relays, designed primarily for alternating-current service and for use in protecting circuits and connected apparatus in general, in cases of overcurrent and short circuit. General Electric Company, Schenectady, N. Y.

Battery Locomotives — Transfer Cars.—Bulletin 1237, 16 pp. Describes storage battery locomotives, special cars for transportation of transformers, coal and ash cars, turn tables and other equipment supplied to central stations and large industrial power plants. The Atlas Car & Manufacturing Company, Cleveland.

Welded Pipe Gas Lines.—Bulletin 510, 52 pp. Describes "Smithwelded" pipe for gas lines. The bulletin includes detailed methods for determining design, stresses, weights, costs, etc. Photographs are included of some of the installations, which range in length to over 700 miles. A. O. Smith Corporation, Milwaukee.

Ash Conveyors.—Bulletin, 20 pp. Describes "Nuveyor" ash conveyor systems, designed primarily to meet the requirements of clean and economical ash disposal for large power plants. The capacities of such systems range from 3 to 30 tons per hour, and may be used in conjunction with either stoker-fired or pulverized fuel firing. United Conveyor Corporation, Old Colony Building, Chicago.

Smoke Recorder.—Circular. Describes the new L & N smoke recorder. The recording installation consists of a measuring chamber at the stack or breeching, a chart recorder at any convenient location, and an indicator at the boiler. For central stations these devices assist in meeting ordinance requirements, maintaining minimum smoke density and inducing economy in firing. Leeds & Northrup Company, 4901 Stenton Avenue, Philadelphia.

Fans.—Bulletin 41, 12 pp. Describes "Century" fans for alternating and direct-current, stationary, oscillating, ceiling and ventilating fans. Included in the bulletin is a new 8-in. one-speed fan for alternating current; also the "Reversair" 36-in. and 60-in. a-c. ceiling fans in which the direction of the rotation of the fan may be reversed, permitting either upward or downward air delivery. Century Electric Company, 1806 Pine Street, St. Louis.

Street Lighting.—Catalog 218-A, 126 pp., "Utilitarian Street Lighting Equipment," and catalog 218-B, 100 pp. "Ornamental Street Lighting Equipment." The former publication describes types of street lighting equipment in which the current is carried to the lighting units by overhead wiring, to distinguish installations of this character from "ornamental" street lighting systems, in which use is made of underground cable construction. Each of these publications includes general information regarding street lighting installations, descriptions and photographs of various street lighting units, standards and street lighting accessories. Westinghouse Electric & Manufacturing Company, East Pittsburgh.


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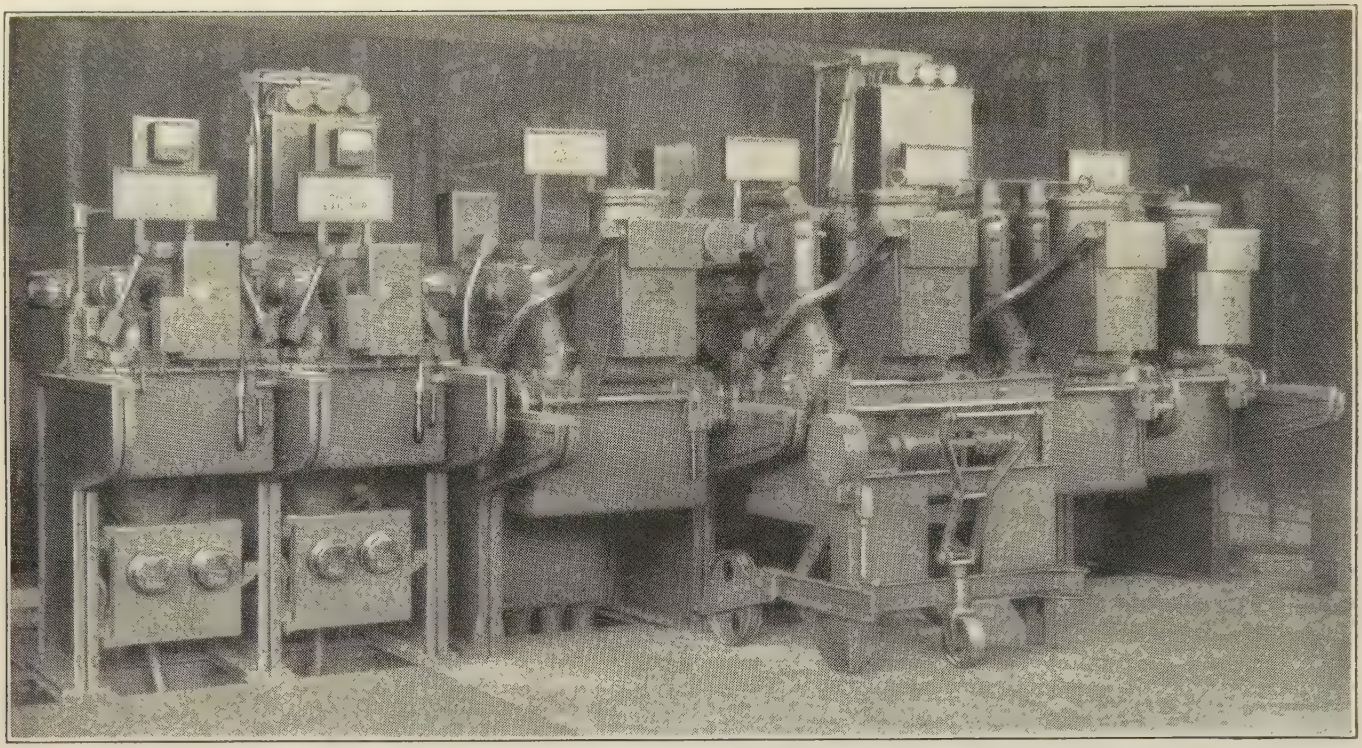
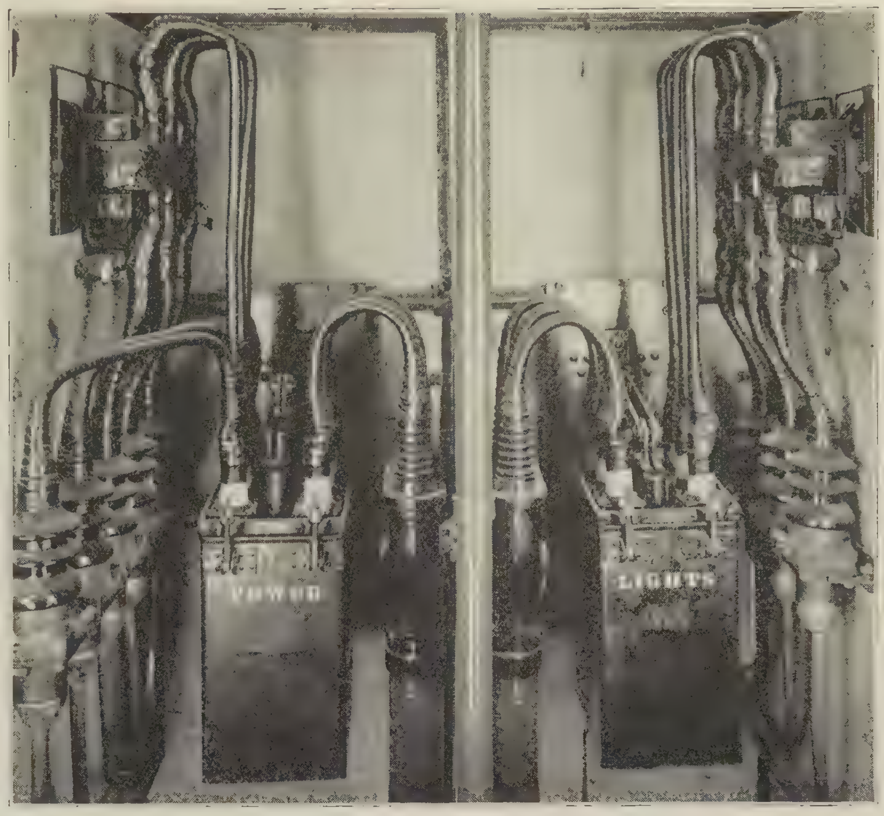
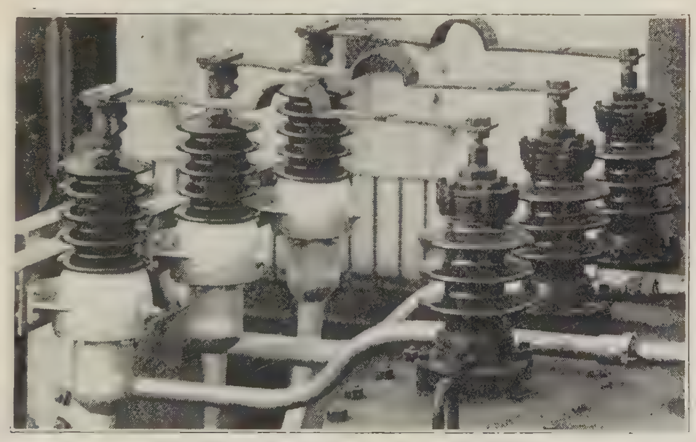




Type "T" Potheads shown on the outer rows and Type "N" at the middle.



G & W Type "T" Potheads, 25,000 volt rating, with style 18 flat bus contact lug.
Note bend in bus bars to prevent expansion and contraction strains.

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LIKE THE
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A quarter century experience in making potheads counts for a lot in the freedom from worry about the details.

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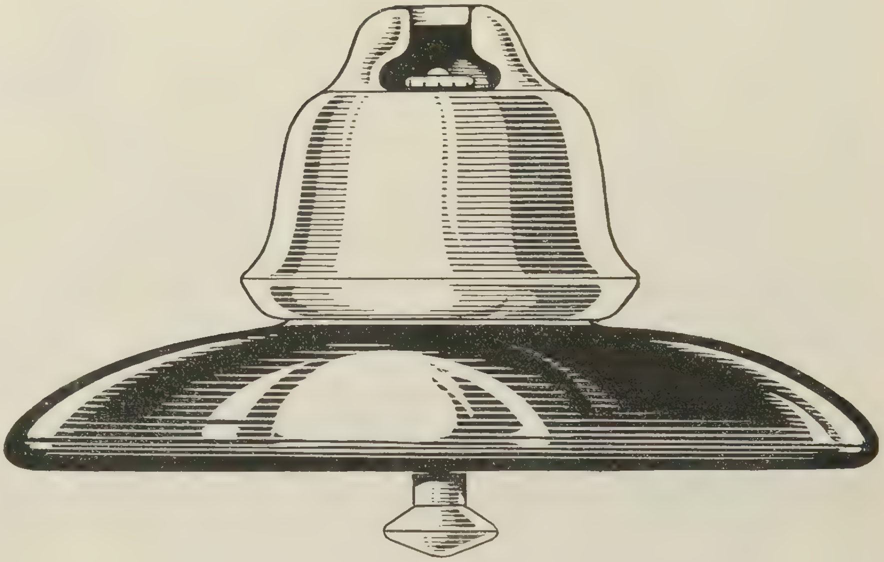

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SPACING—5¾ in.

Made also in Clevis type and with various spacings.

"23,500 lbs. ultimate." The motor hummed quietly. The "juice" hissed. "21,600 lbs. M&E—21,600 lbs. ultimate."

Another insulator. "25,150 lbs. M&E—25,150 lbs. ultimate."

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And yet again, "23,800 lbs. M&E — 23,800 lbs. ultimate."

And so on, hour after hour, the Amsler Machine in the corner of the Locke three million volt laboratory pulls them to pieces, testing and retesting this remarkably uniform standard suspension insulator.

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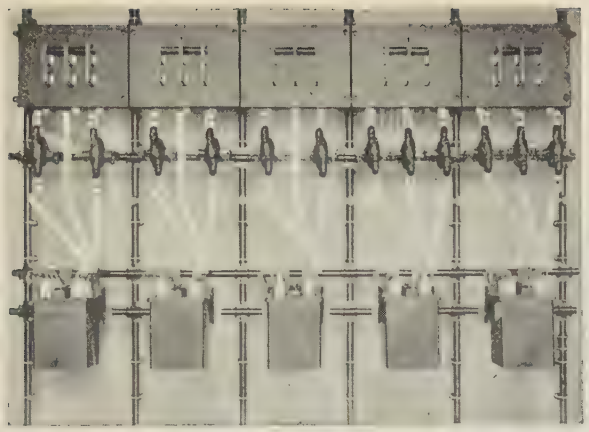
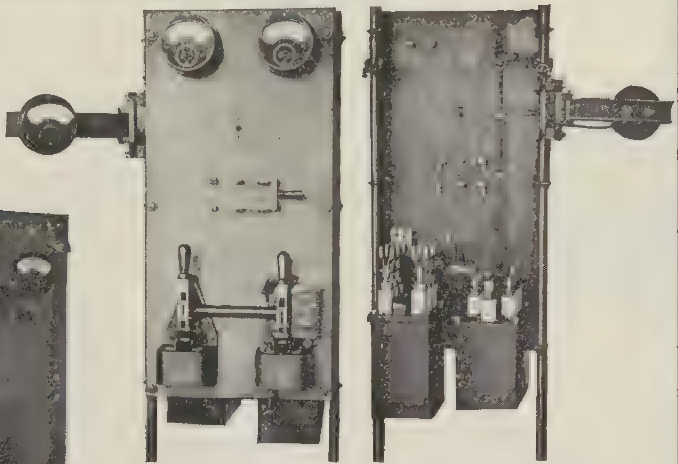
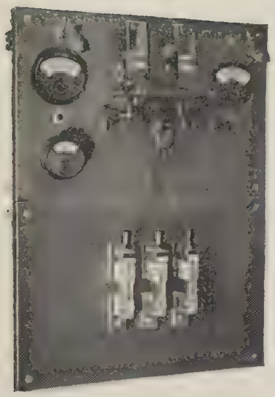


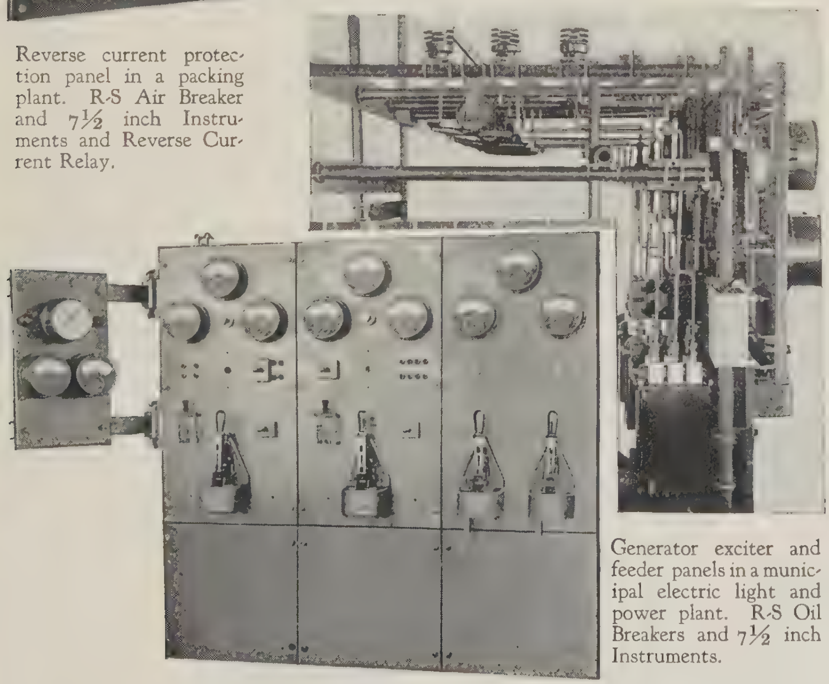
Special control panel in a large industrial plant. R-S Oil Breakers and Horizontal Edgewise Instruments.



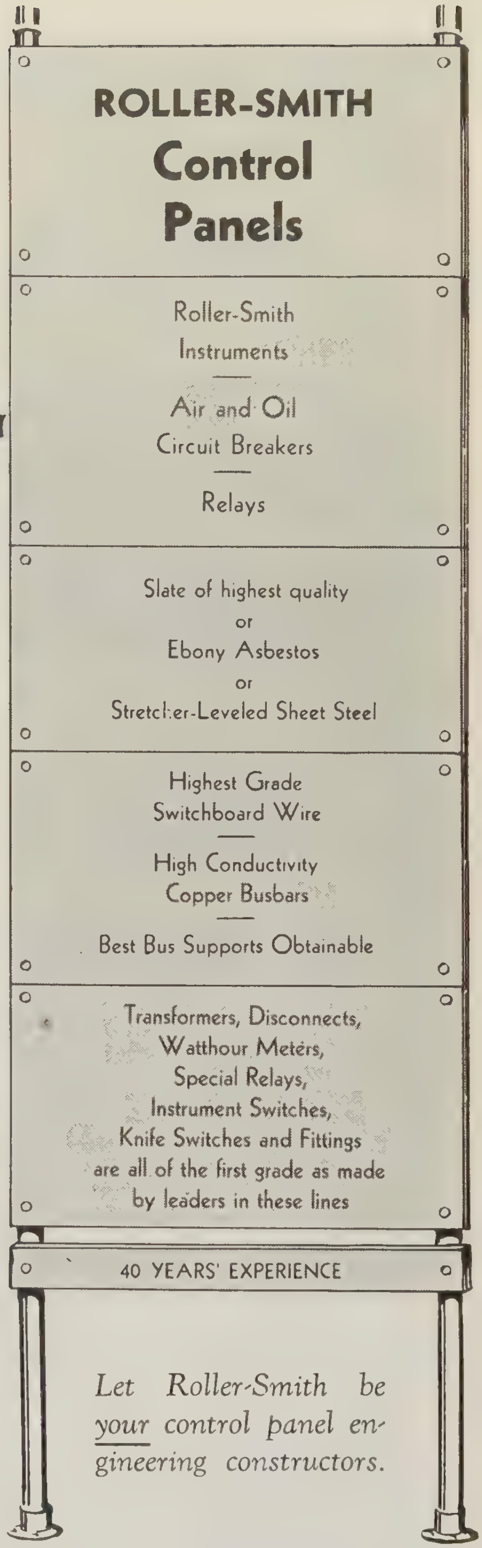
Front and rear views of synchronous motor starting panel in a dye plant. R-S Oil Breakers and 7½ inch Instruments.



Reverse current protection panel in a packing plant. R-S Air Breaker and 7½ inch Instruments and Reverse Current Relay.



Generator exciter and feeder panels in a municipal electric light and power plant. R-S Oil Breakers and 7½ inch Instruments.



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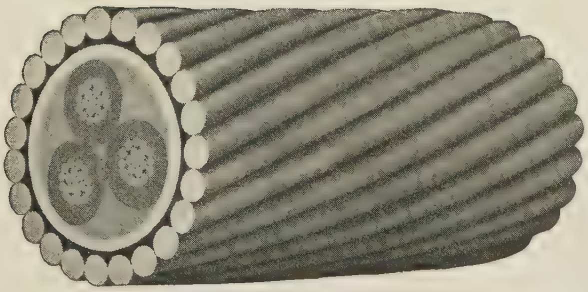

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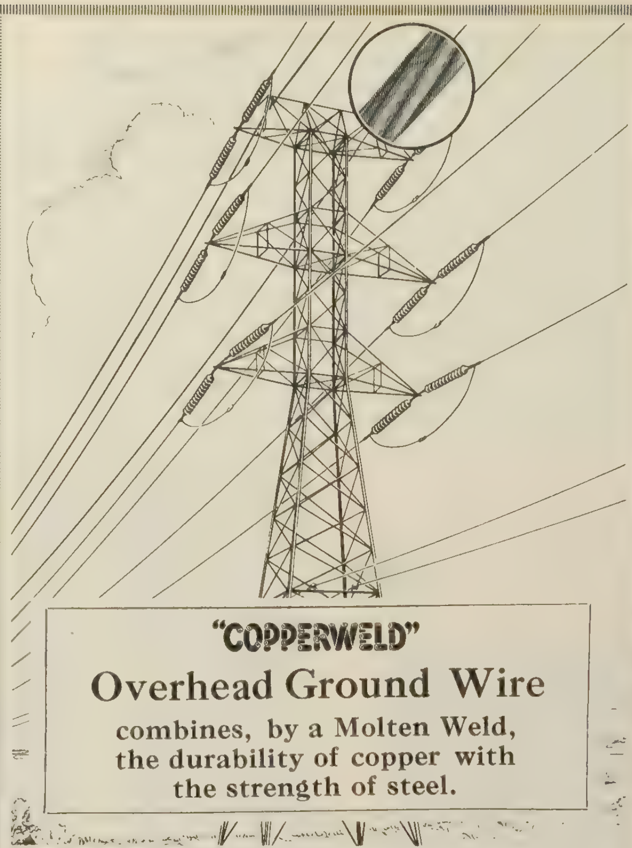

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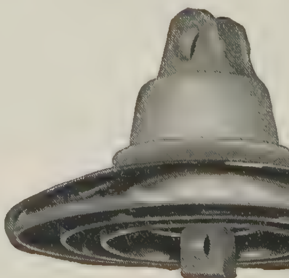

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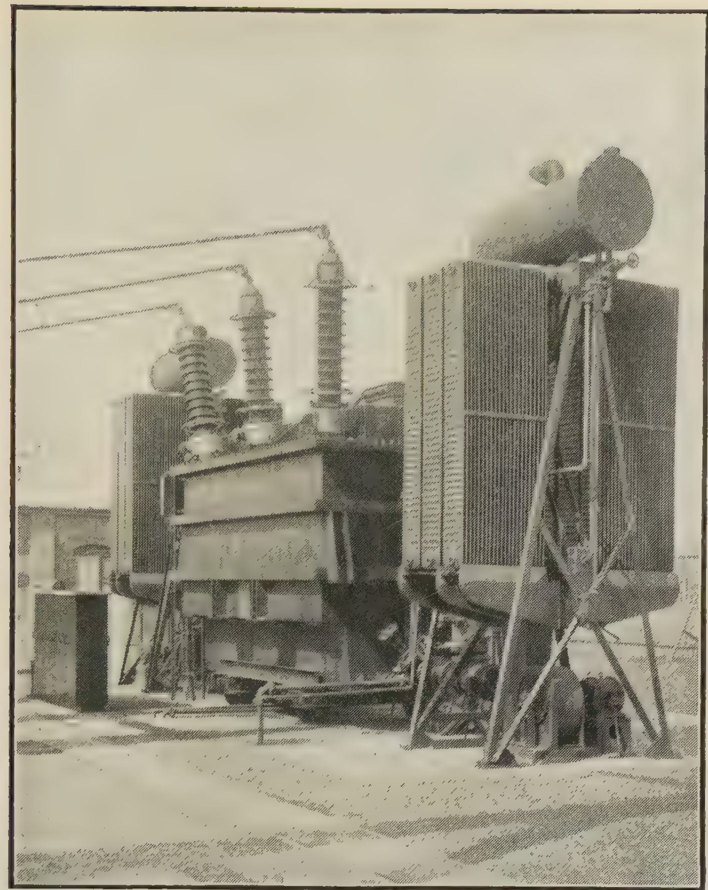

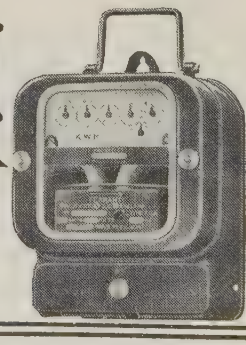

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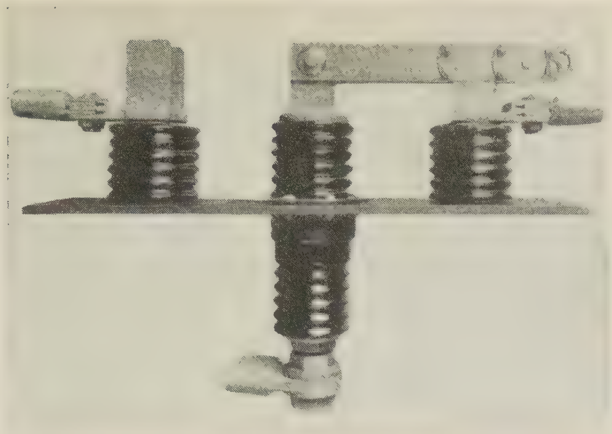

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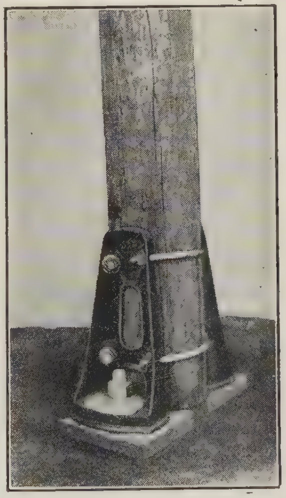

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measuring small electrical quantities

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Weston Model 322 may be used *without leveling* because its movement, which is of the permanent magnetic movable coil type, is double pivoted. This makes for sturdier construction without materially increasing the operating period.

Model 322 is made as D. C. Microammeters, Millivoltmeters, and Pyromillivoltmeters. As Microammeters, it is available with one, two or four ranges. The latter two are provided with a range changing switch. This instrument is available for measuring of currents as low as 25 microamperes at full scale deflection.

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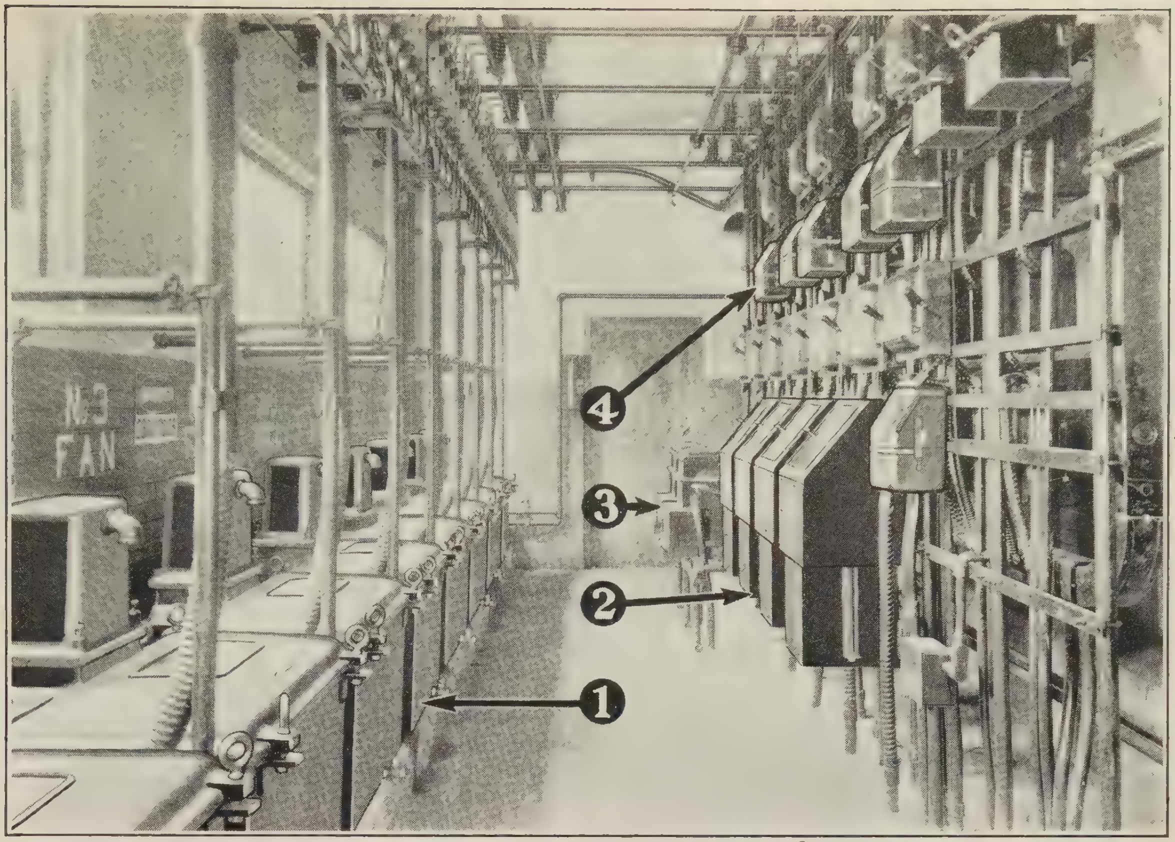

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Throughout this entire refinery, more than 450 EC&M Oil-Immersed Motor Starters are used. As shown, they consist of: 1—EC&M High Voltage Automatic Compensators; 2—EC&M Low Voltage Automatic Compensators; 3—EC&M Type ZS Across-the-line Automatic Starters and 4—EC&M Type ZO Across-the-line Automatic Starters.

Each and every one of these starters is of the oil-immersed type which, combined with the EC&M high standard of accurate machining and rugged construction, assures extraordinary dependability—a dependability that does not fade.

These starters require infrequent attention, are dustproof, corrosionproof and well lubricated . . . thus, they are always in operating condition. The oil-immersed feature makes them so—no matter whether they are out of service for a few hours or for several months.

This is only one of the many large plants that recognize the unfailing dependability of EC&M Oil-immersed Control. Bulletins 1042-G, 1047-A, 1048-J and 1062 show many other interesting installations in all types of industries. Write for your copies.

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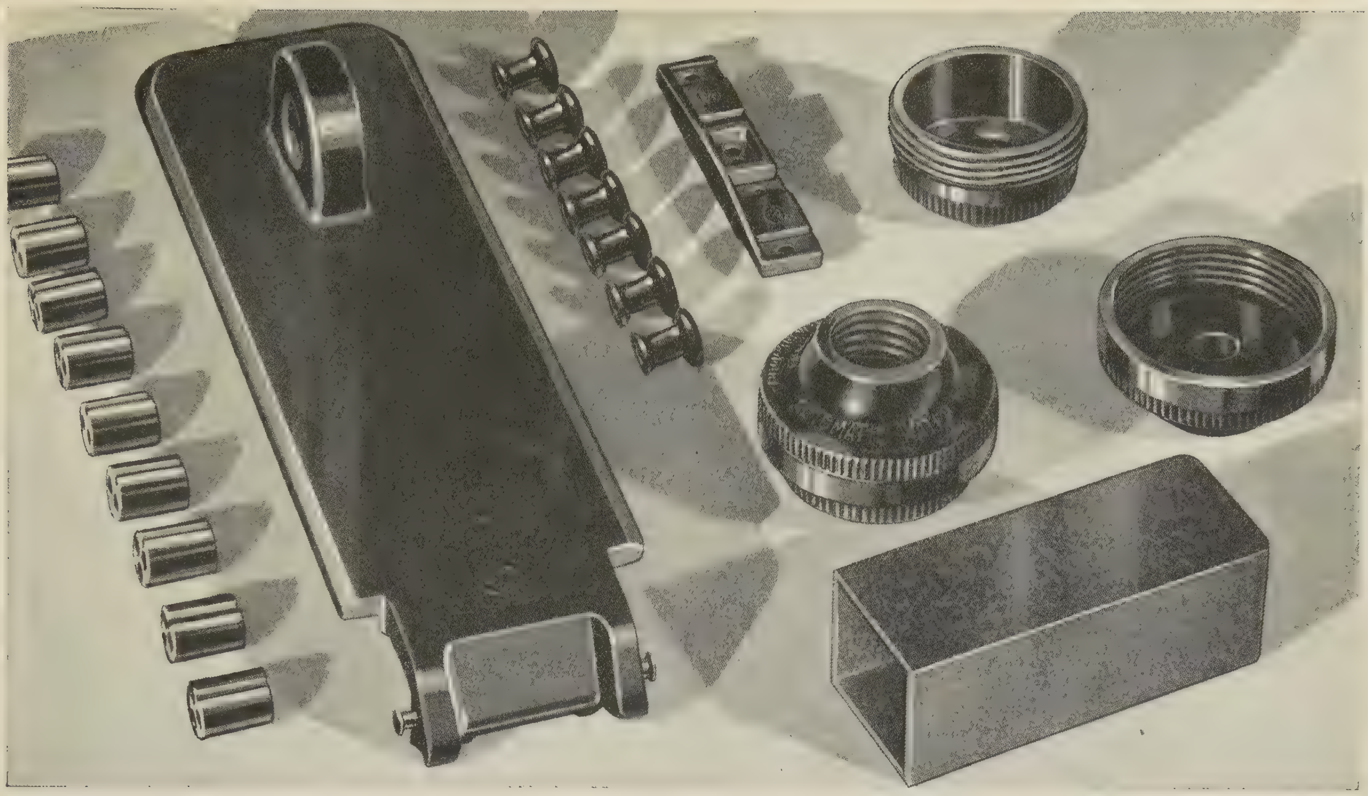

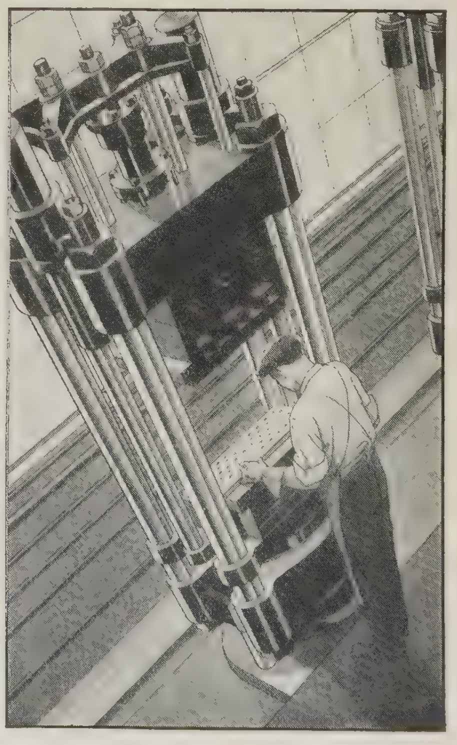

Scientists study effect of *Vibration* on fastening devices

"It is evident that fastenings made with Self-tapping Screws will resist vibration much better than machine screws" say authorities of the COLLEGE OF ENGINEERING OF N. Y. U. *after tests.*

FOR weeks scientists of the College of Engineering of New York University studied the holding power of fastening devices. By unbiased tests they were to determine whether Self-tapping Screws, noted for economy in assembly work, have greater or less holding power than the fastening devices they usually replace.

Particular attention was given to the effect of vibration, for it is the chief cause of fastening failure. The specially constructed vibrating machine, shown above, was run more than a hundred hours under close observation. Four test specimens were subjected to the vibration—each specimen containing two sizes of Self-tapping Screws, and an equal number of the equivalent sizes of machine screws, the most common alternative means of fastening.

Early in the test the majority of the fastenings made with machine screws failed. *Yet not a single Self-tapping Screw loosened.* The report of the authorities conducting the test states:—"It is evident that Parker-Kalon Hardened Self-tapping Screws will resist vibration much better than the conventional machine screw".

Detailed information developed from the extensive tests made at N. Y. U. of the comparative strength of fastening devices under stresses of vibration, tension and shear will be found in the booklet offered here. The coupon brings it, free; with another helpful booklet showing the large savings gained on metal assemblies through the use of these unique Screws that eliminate tapping, fumbling with bolts and nuts and other fastening difficulties.

PARKER-KALON CORPORATION
198 Varick Street, New York, N. Y.

Send me free booklets on the Security and Economy of assemblies made with Self-tapping Screws.

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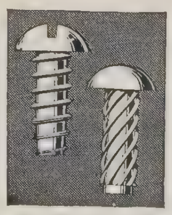

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HARDENED
Self-tapping Screws

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He no longer flies alone!

Formerly a man a mile above the earth was shut off more completely than if he were in the heart of Africa or the depths of the frozen north.

Now the Western Electric radio telephone ends that isolation. The flier whose plane is equipped by Western Electric is always in touch with ground stations, and he flies with greater dispatch and greater safety.

This telephone for airplanes grew out of many years' experience in making telephones and other apparatus for the Bell System. It is one more example of Western Electric's skill in the art of voice reproduction.

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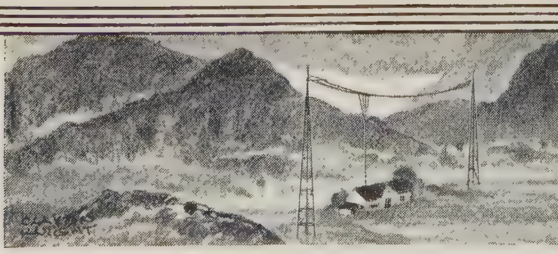
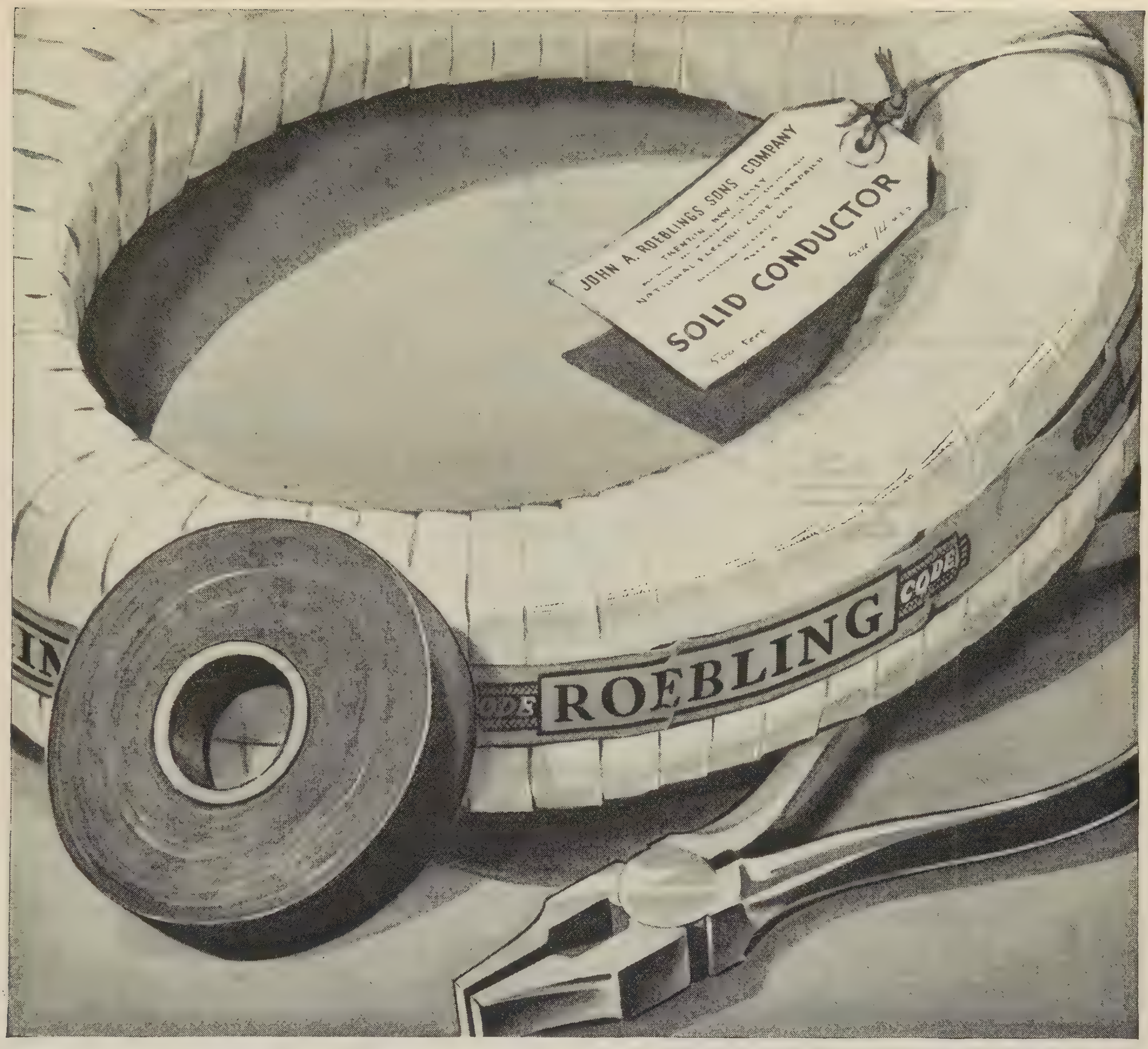


The nation's leading airlines safeguard their passengers with Western Electric Airplane Radio Telephone



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THERE is hardly a type of electrical wire or cable that Roebling does not make. The Roebling Line ranges from hair-fine magnet wire to heavy high tension power cable.

To provide on-the-dot service, complete stocks of all standard constructions of magnet, weatherproof, rubber-insulated and many other Roebling Wires and Cables are carried at the warehouse points listed below.

For full information write or phone for a copy of the Roebling Electrical Wires and Cables Catalog or refer to the McGraw-Hill Electrical Trade or Engineering Catalogs.

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Power Cables : Paper; Cambric; Rubber » Submarine Cables » Tree Wire » Parkway Cable » Service Cables » Station Cables » Rubber Covered Control Cables » Rubber Covered Wires and Cables · Braided and Leaded · Code: Intermediate; 30% » Slow-burning Wires and Cables » Weatherproof Wires and Cables » Portable Cords » And a wide variety of other wires and cables.

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Index to Advertised Products—*Continued*

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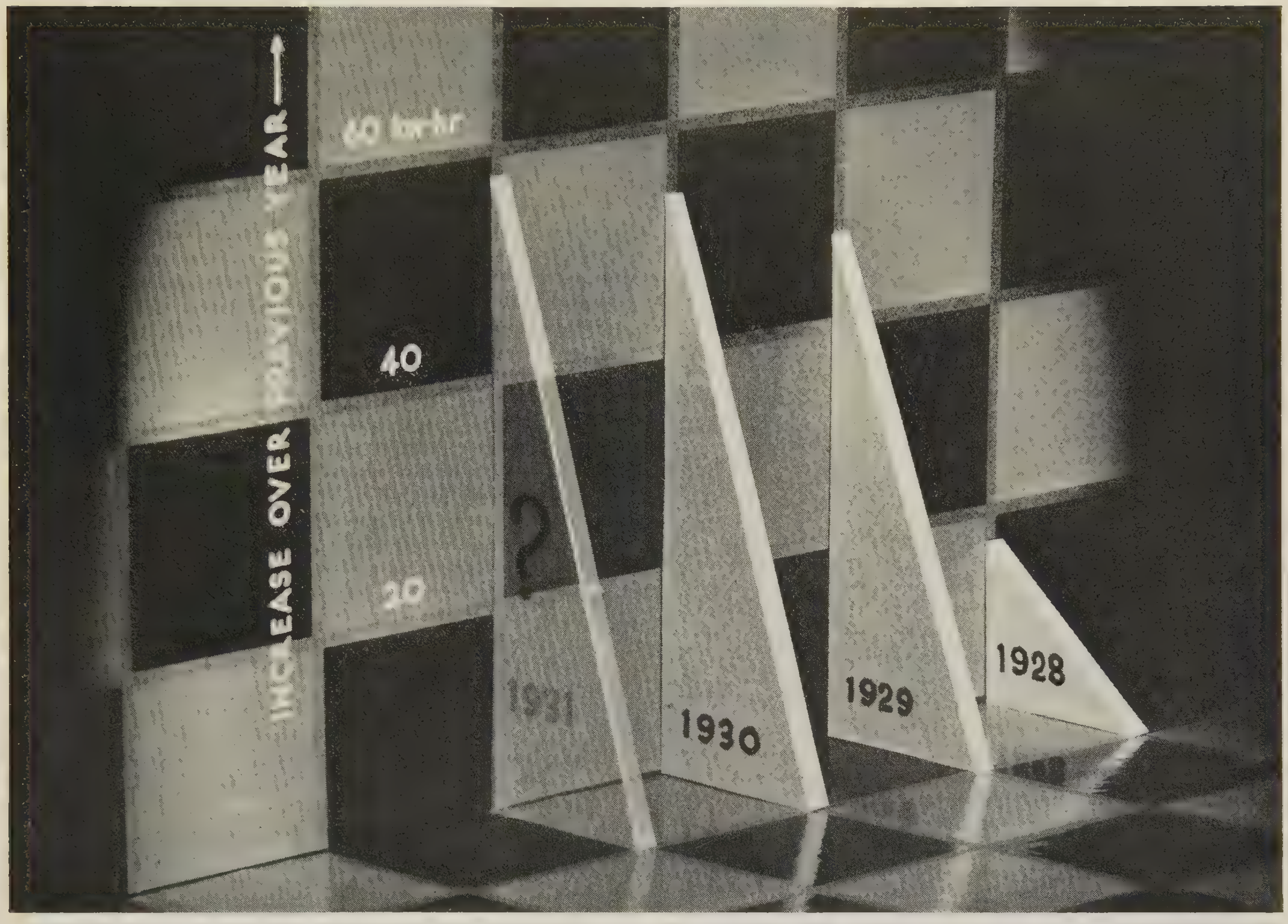
IN 1931?



In 1927, we began to preach more-load-per-customer as the way to more revenue. Then the average annual residential consumption was 450 kwhr . . . in 1930, it was 572 kwhr, an increase of 27%! Each year this growth has been more rapid. In 1928, the kilowatt-hour increase was 18; in 1929, 49; and in 1930, 55. What it will be in 1931 depends upon the quantity and quality of effort put forth.

More-load-per-customer campaigns are not confined to big companies . . . because the grand average increase of the whole industry is very close to the performance of some of the biggest Utilities. Building load with appliances is in the air . . . don't overlook the purpose . . . which is to increase revenue . . . and be sure you get all the revenue.

Increasing appliance loads requires modern meters. The Sangamo HC is the more-load-per-customer meter. The HC is the correct meter when loads are increasing . . . when peaks are frequent . . . when power-factor is low. The HC is not affected by temperature. While loads are building, the HC will measure the peaks and thus, without loss of revenue, bridge the gap to the final load which will require a larger meter.

SANGAMO

ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

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Index to Advertised Products—*Continued*

ALPHABETICAL LIST OF ADVERTISERS

FOR VALUE RECEIVED

A GREAT MANY PEOPLE will tell you that the biggest single service that five cents can buy today is a local telephone call. Without question, it is big value . . . and value that steadily grows as new telephones come into your neighborhood.

There are times when telephone service is priceless . . . when the ability to call instantly a doctor, a policeman, or the fire department could not be measured in terms of money.

But it is not alone the emergencies that give the telephone its value. There are the commonplaces of every-day conversation . . . in the home, the shop, the office . . . whenever you wish two-way communication with any one, almost anywhere.

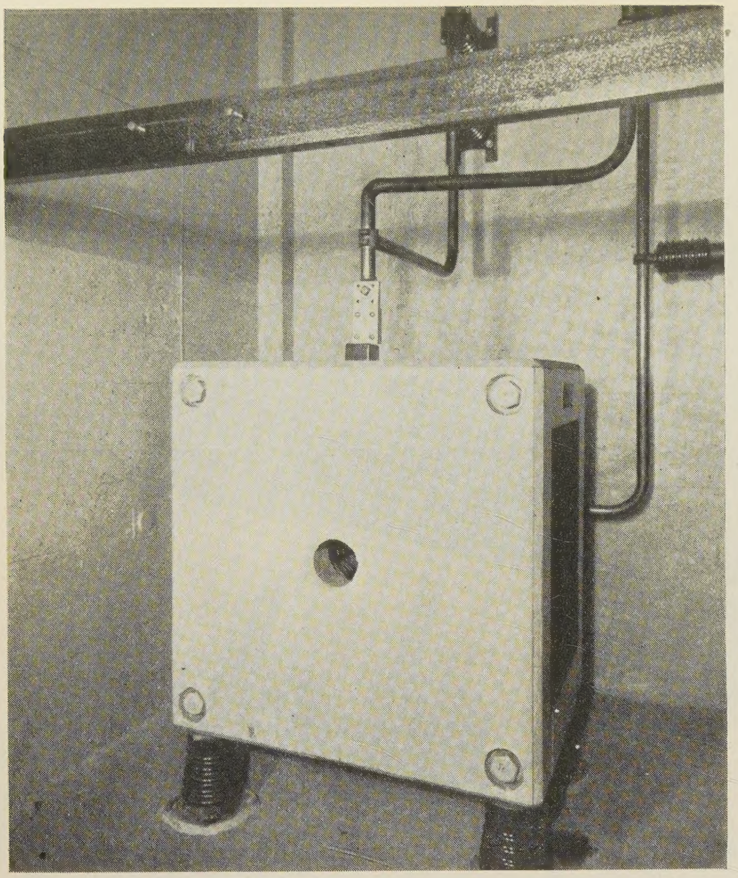
The telephone has become such an everyday, matter-of-fact convenience—like running water and electricity—that it is natural to take it for granted. It is well to pause occasionally and consider the nation-wide organization of men, money, and materials that makes this vital service possible, and at such low cost.

Here is a system of the public, for the public . . . run on the barest margin of profit consistent with service, security, and expansion. A service that grows as the community grows . . . placing within the reach of an increasing number the means to talk back and forth with people in the next block, the next county, a distant state, a foreign country, or on a ship at sea!

No other money that you spend can bring you more actual value.

★ *AMERICAN TELEPHONE AND TELEGRAPH COMPANY* ★

AMERICAN TELEPHONE & TELEGRAPH CO.
BELL SYSTEM
AND ASSOCIATED COMPANIES



Installation of 26,000 Volt Indoor Type Murray Low Loss Reactor, Rated at 150 Kva., 333 Amp.

Highest All Year Efficiencies

Highest Short Circuit Protection

MURRAY Low Loss* Reactors

*TRADE MARK REGISTERED

Lowest Temperature Rises and Smallest Space Requirements

Murrary Low Loss Reactors react to your advantage and pay big dividends.

They are used by practically every large lighting company in the United States.

No reactor need is too small,—none too big.

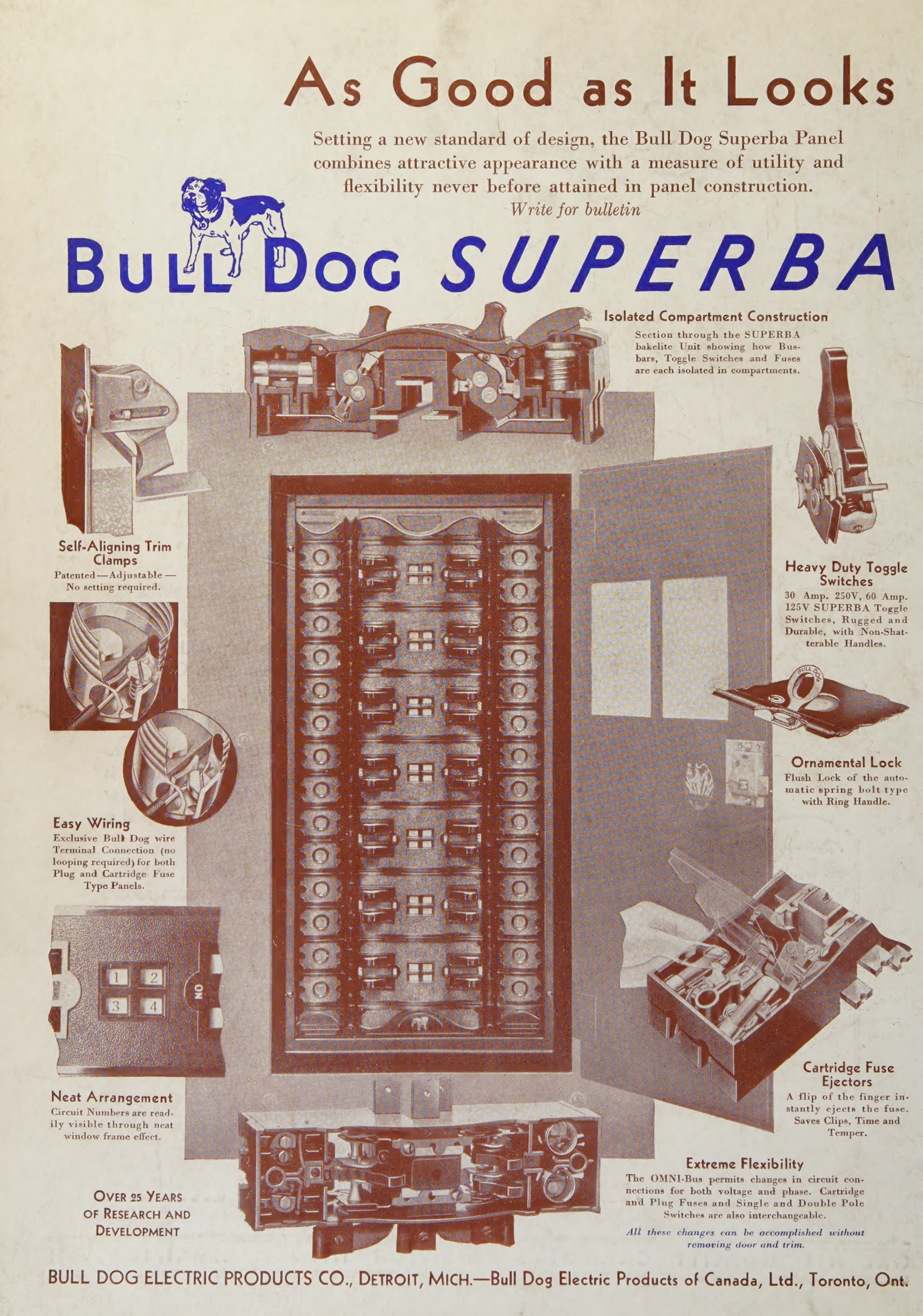
Murrary Low Loss Reactor protection doesn't "cost"—it pays."

We are ready to lay out a protective system that will answer your particular requirements upon receipt of engineering data.

PIONEERS IN REACTOR PROTECTION

METROPOLITAN DEVICE CORPORATION
BROOKLYN—NEW YORK

OVER 900,000 REACTOR KVA. RATINGS MANUFACTURED


As Good as It Looks
Setting a new standard of design, the Bull Dog Superba Panel combines attractive appearance with a measure of utility and flexibility never before attained in panel construction.
Write for bulletin
BULL DOG SUPERBA
Isolated Compartment Construction
Section through the SUPERBA bakelite Unit showing how Bus-bars, Toggle Switches and Fuses are each isolated in compartments.
Self-Aligning Trim Clamps
Patented—Adjustable—No setting required.
Heavy Duty Toggle Switches
30 Amp. 250V, 60 Amp. 125V SUPERBA Toggle Switches, Rugged and Durable, with Non-Shatterable Handles.
BULL DOG
Ornamental Lock
Flush Lock of the automatic spring bolt type with Ring Handle.
Easy Wiring
Exclusive Bull Dog wire Terminal Connection (no looping required) for both Plug and Cartridge Fuse Type Panels.
1
2
3
4
ON
Neat Arrangement
Circuit Numbers are readily visible through neat window frame effect.
Cartridge Fuse Ejectors
A flip of the finger instantly ejects the fuse. Saves Clips, Time and Temper.
Extreme Flexibility
The OMNI-Bus permits changes in circuit connections for both voltage and phase. Cartridge and Plug Fuses and Single and Double Pole Switches are also interchangeable.
All these changes can be accomplished without removing door and trim.
OVER 25 YEARS OF RESEARCH AND DEVELOPMENT
BULL DOG ELECTRIC PRODUCTS CO., DETROIT, MICH.—Bull Dog Electric Products of Canada, Ltd., Toronto, Ont.